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My Experiences of the Cocoanut Beetle

BY

H. Srinivasa Rao,

Retired Deputy Conservator of Forests, Hongenahalli, Malur Taluk, Kolar District.

AFTER studying cocoanut cultivation for three years when I was in the Tumkur and Hassan Districts I found it to be a paying crop and that it required much less labour than the ordinary field and garden crops, besides being, to a large extent unaffected by the vagaries of the seasons. Owing to the advantages it possessed I resolved on having a fairly large cocoanut plantation and commenced planting in 1912. The area now under this crop is about thirty acres and the majority of plants have made fair progress in spite of the havoc wrought by the beetles. Cocoanut cultivation would have been far more extensive had it not been for this pest. It is the greatest obstacle to raising cocoanut plantations. For the present there is only one beetle which attacks the cocoanut and that is the Rhinoceros beetle. The severity of this pest differs in different seasons of the year and from day to day in one and the same season, according to the weather conditions on each day. These are night beetles and the only way to minimize their ravages is to search for them examining each plant, extract

and kill them, early morning each day, so that they may have as short a time as possible to bore through towards the tender growing tissue.

Taking the seasons of the year the attacks are the largest in the hot season and smallest in the cold season. With the commencement of Utrabhadra or Revati rain (*i.e.*, latter part of March), almost all of a sudden they appear in large numbers and continue doing much damage till about the Hasta rain (*i.e.*, October). From about Hasta they begin to decrease and the number daily picked falls to a third or fourth part of what they would be in the early monsoon. The virulence of the attack may be classified into three degrees corresponding to three seasons of rainfall, *viz.*, the mango showers, the S. W. monsoon and the N. E. monsoon. It is very great in the season mango showers, *i.e.*, from about Utrabhadra (end of March) to *Aridra* rain, the maximum being reached in *Bharani*, *Krittika* and *Rohini* which according to Hindu shastras is said to be the breeding season of insects in general. The average number of daily attacks in my plantation of 1,000 plants would be about from 16 to 25 daily in this season. From about Aridra which corresponds to the latter part of June when the S. W. monsoon winds begin to blow there will be a slight fall in the attacks though inappreciable on many days; and this state of things continues up to Hasta or the setting in of the N. E. monsoon (which corresponds to the middle of October). The number of daily attacks in my plantation of 1,000 trees is found to be about from 12 to 20. From after Hasta rain the attacks diminish appreciably and reach their minimum in the middle of the cold weather to increase with the advent of the hot season again as stated above. The number of daily attacks in my plantation of 1,000 trees have been found to be from about one or two to eight.

Again the attacks are not uniform in number on all days in one and the same season. The number varies according to weather conditions on each day. If the nights are cloudy and the temperature high the attacks are large while on nights with a low temperature the attacks are fewer.

The beetle attacks the palm in all stages of growth from the seedling up to trees twenty-feet in height. When young plants of

one or two feet are put in the beetle having no succulent parts to attack above bores a hole in the ground and reaches the tender tissue below the surface. In grown up plants they mostly attack the newly formed central shoot and bore down the tender portion to the growing point. They also attack the fleshy portion at the base of the midrib of leaves of old trees and bore holes through it and the damaged leaves break and fall down when strong winds blow. The trees with leaves so destroyed look like pollarded trees. The damage caused greatly interferes with the nutrition of the plant. Where the growing tissue is completely destroyed the plaint dies gradually. If at least a portion is left undestroyed a fresh top shoot or a side shoot comes up; in the latter case always forming a knot at the ground level from which the new shoot starts. A side shoot means a great set back of the upright growth inasmuch as the new shoot takes a year or more to come to the height of the original plant. The beetle kills plants even four and five years old if left undetected. When a tree has formed its trunk above ground the depth of crown will be deep and the tough fibrous sheaths which envelope the leaves will have well developed so that the beetle is mostly unable to penetrate deep into the tree. Grown up plants are thus saved the destruction. In my plantation of 1,000 trees where only seedlings of $1\frac{1}{2}$ to 2 ft. were transplanted I had to replant over a 100 vacancies in the 2nd, 3rd and 4th years. The number of vacancies is gradually diminishing year after year and in the current year which is the 7th after planting the number of vacancies has fallen to 43 only.

Various measures have been suggested to counteract the evil effects of beetles. These are :—

(1) To make heaps of rotting wood partly covered with vegetable debris in or near the plantation in order to attract the beetles as such heaps are the favourite breeding place for the beetles, and when the larvae appear pick and kill them.

(2) To deposit one or two handfuls of common salt at the base of the leading shoot. Rain water or the atmospheric moisture dissolves the salt and the salt solution wets the adjoining tissues. The salt coated parts are said to be immune as the beetle avoids salt.

(3) To keep at short intervals pots containing a semi solid mass of castor oil cake soaked in water. This begins to stink in a few days and the beetles are said to fall into the mixture and die having been attracted by the smell of the cake.

(4) To have a belt of toddy trees adjoining cocoanut trees. The beetles are said to prefer toddy date palm to cocoanut and this saves the cocoanut.

(5) To grow field and garden crops in the cocoanut plantation so that the young palms may become not easily discernible amidst other green vegetation. The beetles are said to be not very keen sighted and therefore miss the palms. The crops usually grown are noted below

(6) To keep the plants covered up over the greater part by tying round them dead date leaves and twigs of trees and shrubs, etc.

(7) To examine each plant for beetles early in the morning every day, hook out and destroy those that have come during the previous night.

(8) To make a live fence around each plant.

To deal with the merits and demerits of the several methods enumerated it requires much experience and I am unable to give my opinion about all these as I have not tried many of them. Besides this some of these methods are possible of easy adoption where only a small area or a few plants are concerned and not practicable over large extents.

If I have to deal with them in detail, I must admit I have not tried the first two methods of making heaps of rotting wood and of applying common salt.

I tried the castor cake method as an experiment over a small area and found it unsatisfactory, as no beetle was found in any of the three pots kept for over a fortnight.

Method (4) of having toddy trees (phœnix sylvestris) besides cocoanut is not possible unless these are raised long before cocoanut planting to be of any use as it is a slow grower. The usefulness of this method is clearly proved in tracts where toddy date is already growing as in the Tiptur, Chicknaikanhalli, and Arsikere Taluks and where the damage by beetles is the least so far as cocoanut is concerned.

Method (5) of growing field crops is very effective but it is not practicable in every case and in all seasons of the year.

The field crops generally grown are plantain, betel leaf, sugarcane, sorghum, the dhol plant, sun hemp, cotton and such other tall plants. The first three crops requiring as they do high cultivation and constant irrigation can only be grown on small extents but these are very effective in keeping off beetles. No beetles were traced amidst sugarcane and in the betel leaf garden cocoanut thrives well in their association. Sorghum, dhol and sun hemp are also effective so long as they stand on the ground but they stand on the ground only for a part of the year. Cotton not only does not afford effective protection being low but seems to act injuriously on cocoanut as the latter turned yellow and put on a sickly appearance in association with cotton. Further experiments are necessary to ascertain the truth or otherwise of what I have observed. I am now trying mulberry between cocoanut. As mulberry requires high cultivation cocoanut will be much benefited by it. If this is found useful it will be a happy combination as both are valuable crops.

Method (6) of making the palm leaves invisible by tying up date leaves and twigs is a successful one and is always resorted to in the main cocoanut belt of the Tumkur District where date leaves are used. In the absence of date leaves I have used twigs of Dodoneæ viscosa. Though a successful method it seems to interfere with the free æration and nutrition of the plant. The real merits of this have also to be determined by careful experiments.

The seventh method of visiting each plant every morning and picking out the beetles that might have come in during the previous night is fit for general adoption. It is effective when the work is carefully done but occasionally the beetles escape notice and do damage. One man can look after about 500 plants working till noon. This method though useful is not free from defect as at least some damage will have been done before the beetle is picked out.

The eighth method of having a live-fence around each plant is not a sound one. The fence plants generally employed are the Euphorbias. Jatropha curoas is said to do injury

to cocoanut and is not to be used. I raised castor plants round the cocoanut palm. The castor used was the big variety which grows to the size of a small tree. It lives for a few years and dies naturally. The decaying roots of the castor infected the cocoanut roots in contact with a kind of rot which killed the palm. I lost four trees like this in four years. Seeing this I destroyed the castor plants and there has been no further loss of cocoanut afterwards. Euphorbia Tirucally (*i. e.*, ಕೊಳ್ಳಿಕಡ್ಡಿ) is generally planted round as a preventive of beetles; but I have seen beetles attacking even with this fence round. Agati grandiflora (ಅಗಸಿ) is used in some place but even this is not very effective.

Account showing the Income and Expenditure of my Farm for the year 1917

BY

M. Subba Row

Passed Student, Mysore Agricultural School, Muttati Village, T. Narsipur Taluk, Mysore District.

THE area of the farm is 82 acres and 24 guntas, of which 35 acres are wet, 19 acres and 28 guntas dry. The remaining 27 acres and 36 guntas of dry land is pasture. [1 gunta = 1/40 acre]

I. Nature of Soil.

(*a*) *Wet lands.*—These are commanded by the Rajaparameswari Channel. The land is situated on the right bank of the Cauvery river. As the land is about 25 ft. high above the level of the river bed, it has a perfect drainage. Nearly 20 acres and 20 guntas are sandy loams very porous, hungry and not able to retain moisture in the soil. 6 acres and 20 guntas are light sandy loams, moderately fertile. 3 acres contain clay soil not so fertile as sandy loams. 3 acres are light alkali soils. As the drainage is somewhat good it is yielding moderately. The remaining two acres have patches of alkali soil. To remove the patches, Euphorbia Tirucalli was trampled before transplanting.

Alkali has improved somewhat and I think a regular application of it for some years more may remove the Alkali.

(*b*) *Dry lands*—Consist of red sandy loam and red loam. In the former crops do not thrive well during heavy rains. In the latter it does well.

II. Value of the Land.

The value of the wet land comes to Rs. 27,000 and that of dry land and pasture comes to Rs. 2,000.

III. The Farm Buildings.

The building including the cattle-stall, etc., are located in the dry area about ½ a mile from the wet land. The value of the building comes to Rs. 2,000.

IV. Method of Cultivation of the Lands and the Nature of the Crops grown in the year 1917.

(*a*) *Wet lands.*—Soon after harvest all the lands were ploughed once on the 8th February. There were a few showers which enabled us to raise some Leguminous catch crops. Nearly 3 acres were sown with Green-gram and Cowpea or Halasande. This area was not manured on account of unexpected rain. Only 20 acres of mixture, mixed in equal quantities, was sown. Only pods were collected, 4 times till the the end of May. The wages for collecting pods were not paid in the shape of money, but the coolies got ¼ of the pods they collected. Excluding harvesting expenses, the produce was 1¼ palla of Green-gram and 2 pallas and 30 acres of Cowpea. [1 palla = 100 seers]

Besides this, 2 acres of Iron Cowpea was sown on the 15th May in an area of 10 guntas. The pods of this were up by the 15th of July. The yield was 55 seers. This was manured at the ordinary rate. On March 26th the manure was carted to 30 acres at the rate of 6 cart-loads per acre. For the nursery bed which was 2 acres in area 24 cart-loads were applied.

The sowing of green manure crops such as Sun-hemp and Horsegram began on the 13th April, and lasted for a month expecting rains every now and then. The seed rate of the mixture is 9 seers per acre.

Raising Nursery.

Paddy was broadcasted in manured dry nursery beds well prepared with 5 ploughings. The date of the sowings is given below :—

Particulars.	Quantity.	Date.	Remarks.
1. White paddy (Bili Sanna Bhatta)	8 pallas	8--6--1917	Soon after a few showers.
2. White paddy (Do)	3½ ,,	16--6--1917	Irrigated after sowing.
3. Shimoga Sanna	1 ,,	,,	,,
4. Nagpur fine	50 seers	,,	,,
5. Red paddy (Kempina Sanna)	2 pallas	29--6--1917	,,

On 20th July 16 acres were irrigated and puddled by one ploughing and allowed to rot for 6 to 7 days. In the meantime the lands were repaired by the permanent coolies. Afterwards it was ploughed a second time and levelled roughly by both permanent and temporary coolies; it was then transplanted by female coolies. The remaining land was irrigated on the 3rd August. All the tillage operations were done same as above and the seedlings transplanted on the 16th of August. 40 days after transplanting, weeding was done by female coolies.

Harvesting commenced as shown below.

(1)	Nagapur fine	harvested on the	10th	December	1917.
(2)	Shimoga Sanna	,,	14th	,,	,,
(3)	Red paddy	,,	27th	,,	,,
(4)	White paddy	,,	24th	,,	,,
(5)	,,	,,	31st	,,	,,

For harvesting and threshing paddy temporary coolies were engaged along with the permanent men giving wages to the temporary men in the shape of grain at 7 seers per man. The total came to 43 pallas and 10 kolagas (1 kolaga = 5 seers).

Carting paddy was done by the permanent coolies, while for carting straw and stacking, temporary men were engaged paid at 5 annas each day.

Yield.

	Name	A.	Gs.	Yield per acre. P.	K.	Seers.	Total yield. Palla.	Kolagas.
(1)	Nagpur fine	1	25	11	8	4	18	12
(2)	Shimoga Sanna	2	10	11	16	2	26	12
(3)	White paddy	27	10	13	16	2	373	3
(4)	Red paddy	4	5	13	11	2	55	19

Out of the red paddy the wages for the harvesting and threshing men were given, *i.e.*, 43 pallas and 10 kolagas.

Dry Area.

Rotation.

1st year	Ragi	Hingar	Manured.
2nd year	Jola	Mungar crop	Not manured.

Horse-gram or green-gram as a Hingar crop or Second crop.

Hingar Crop Ragi.

7 acres were prepared for Ragi manured at the rate of 7 cart-loads per acre. The land was ploughed 2 times by the Eureka plough and 3 times by the country plough. Ragi was sown on the 15th August at 5 seers per acre in the eight tined "Kurige" distance between two tines being six inches. The same evening there was a heavy rain thereby the soil becoming very compact did not allow the seeds to germinate properly. If a few showers had fallen after 3 or 4 days the seeds could have nicely germinated. After 12 days a few showers fell which allowed us to interculture. Weeding was done a month and a half later, the wages for the female coolies being one anna and eight pies per half a day. It was harvested on 3rd September and threshed later on. This was done by the permanent coolies. Along with this half a seer of Niger was also sown as an Akkadi crop; only a 3 anna crop was realised.

Jola.

In the early Mungar rains that is on 20th April Jola was sown in 6 acres in ploughfurrows of one foot apart. Two female coolies were engaged for sowing. Interculturing was done twice by the permanent coolies a month and a half later. Seed-rate is 5 seers per acre. It was harvested on the 12th August and harvesting coolies were paid in the shape of grain. Stacking and

threshing was done by the permanent men. The yield was only 7 pallas and 5 kolagas. As the rains failed in the months of May and June only a 8 anna crop was realised.

Second Crop in the Jola Fields.

Out of 6 acres 2 acres were sown with green-gram, the seed rate being 6 seers per acre. On 20th September weeding was done. Pods were picked on the 11th November. $\frac{1}{4}$ of the produce was given as wages. The yield was only one palla and six seers.

Horse-gram was sown for the remaining 4 acres on 3rd September. For the remaining 6 acres and 28 guntas horse-gram was broad-casted having poorly manured. The seed-rate for all the above horse-gram fields is at 8 seers per acre. The yield of the whole was only 9 pallas that is to say an 8 anna crop.

Income of the Farm.

Wet Lands.

From catch crop :—

	Total yield.	Price per palla.	Total value.
1. Green-gram	1 palla 5 Kol.	at Rs. 14 0 0	Rs. 17 8 0
2. Cowpea	2 „ 6 „	„ 12 0 0	„ 27 9 7
3. Iron Cowpea	0 „ 11 „	„ 20 0 0	„ 11 0 0
From paddy crop :—			
1. Nagpur fine	18 „ 12 „	„ 9 0 0	„ 167 6 4
2. Shimoga Sanna	26 „ 12 „	„ 8 0 0	„ 212 12 9
3. White paddy	373 „ 3 „	„ 6 0 0	„ 2,238 14 0
4. Red paddy	12 „ 9 „	„ 6 0 0	„ 74 12 5
Income of wet lands, Total ...			„ 2,749 15 5

Income of Dry Lands.

	Total yield.	Price per palla.	Total value.
1. Jola	7 palla 5 Kol.	at Rs. 7 0 0	Rs. 54 12 0
2. Ragi	2 „ 10 „	„ 7 0 0	„ 17 8 0
3. Green-gram	1 „ 1 „ 1 sr	„ 15 0 0	„ 15 14 5
4. Niger	0 „ 3 „ 3	„ 8 0 0	„ 1 8 0
5. Horse-gram	9 „ 0 „ 0	„ 6 0 0	„ 54 0 0
Total income of dry lands ...			„ 143 10 5

	Rs.	A.	P.
Total income of wet lands ...	2,745	15	5
,, dry lands ...	143	10	5
Total value of straw (wet and dry)	250	0	0
,, the manure ...	200	0	0
Total inoome ...	3,342	9	10

Expenditure.

Permanent establishment :—	Rs.	A.	P.
Wages of 7 men at 5 rupees per month per year	420	0	0
One clerk on 8 rupees per month per year ...	96	0	0
Carpenter and blacksmith ,, ...	20	0	0
Horse-gram for cattle ,, ...	96	0	0
Miscellaneous expenses	24	8	0
Total ...	656	8	0

Temporary establishment :—	Rs.	A.	P.
Wages of 16 men for spreading manure at 5 annas each	5	0	0
Wages of the male coolies during transplanting season at 5 annas each ...	40	4	0
Wages for female coolies for transplanting at 3 annas each	68	8	0
Wages of female coolies for weeding in wet lands	6	1	0
Weeding expenses for Ragi and green-gram	9	12	0
Jola thinning and sowing at 2 annas each ..	1	4	0
Horse-gram harvesting	15	0	0
Wages for stacking paddy straw ...	5	0	0
Price of seeds :—			
Sun-hemp 2 pallas at Rs. 12 each palla ...	24	0	0
Horse-gram 2 ,, ,, 6 ,, ...	12	0	0
Green-gram and Cowpea 20 seers ...	4	0	0
Paddy 13½ pallas at Rs. 6 per palla ...	81	0	0
Nagpur fine paddy ½ a palla at Rs. 9 ...	4	8	0
Shimoga Sanna 1 ,, 8 ...	8	0	0
Iron-cowpea 2 seers ...	0	6	4
Ragi and Niger	3	10	0
Jola	3	8	0
Green-gram for dry land	2	0	0
Manure	200	0	0
Straw for cattle	250	0	0
Total ...	1,400	3	4

Brought forward ...	1,400	3	4
Assessment for wet lands	234	15	10
,, dry lands	36	14	9
Interest on money advanced to coolies Rs. 600 at 12% per annum ...	72	0	0
Depreciation on implements at 4% ...	9	6	4
Total ...	1,753	8	3
Net income ...	1,589	1	7

In order to calculate what rate of interest this income works out on the capital invested, this is valued as below :—

Capital.

	Rs.	A.	P.	Rs.	A.	P.
Dead stock :—						
Value of the land both wet and dry				30,000	0	0
Farm buildings ...				2,000	0	0
Implements :—						
12 ploughs at one rupee each.	12	0	0			
6 improved ploughs ...	38	0	0			
1 Cultivator ...	7	0	0			
6 Kuntes	6	0	0			
1 12-tined country harrow	2	0	0			
1 Chaff cutter ...	46	0	0			
6 Yokes	3	0	0			
3 Carts	150	0	0			
Mumties and other tools	20	0	0			
Total ...	284	0	0	284	0	0
Live stock :—						
5 pairs of bullocks ...	700	0	0			
Cattle	750	0	0			
Total ...	1,450	0	0	1,450	0	0
Grand Total ...				33,734	0	0

The net income of Rs. 1,589-1-7 amounts to an interest of 4¾ per cent on this capital.

Conclusion.

There are some special reasons for not realising more in this concern :—

1. By the failure of rains at proper seasons.
2. In wet lands by the failure of early Mungaru rains the green manure cannot be sown early so to increase the bulk of green manure and to raise some catch crops. Soon after the installation of Electric Plant in Sivasamudram the hot weather supply in the channel was entirely stopped. Before that, by the use of that supply in summer we used to raise some catch crops such as, green-gram and cowpea and bulky green manure crops such as sun-hemp and horse-gram. Then we used to get at least 20 rupees per acre by catch crops and 20 per cent more in the paddy yield than at present. To get a good crop the seedlings for transplanting must be healthy and grown up ones, that is, two months old. By the present system as the water is allowed in the channel in the month of June, paddy has to be sown late and the young seedlings are to be transplanted.
3. As the water is allowed only for 7 months that is from June to January 15 money crops like sugar-cane, etc., cannot be grown ; paddy is the only importment crop that can be grown.

Economic Transplantation of Paddy in the Malnad

BY

D. G. Ramachandra Rau

Assistant Director of Agriculture.

MALNAD, as the name implies, is the hilly country of Mysore. Being situated in the west coast, it is the happy recipient of a heavy rainfall which varies from 60 to 380 inches per annum. Here paddy is the staple crop and it is mostly rainfed. Occasionally however its irrigation is supplemented by small tanks that hold a meagre supply of water. The climate is notoriously unhealthy and the population sparse. Labour is neither efficient nor adequate. In a country of this description as may naturally be expected, sowing of paddy must be the rule and transplantation the exception. Neverthless, as the substantial benefits of transplantation are widely known, enterprising ryots take it up wherever labour and water are available. Further more, the lower terraces—into which water is all collected and cannot be drained off, during the monsoon—are unsuited for sown paddy and the crop has perforce to be transplanted in these low areas.

The manure supply is scanty and a major portion of it is liberally given to the money paying areca, pepper, etc. The nursery beds as well as the fields of paddy do not come in for a good share and cannot receive rich doses.

The nursery bed is sown unimaginably thick receiving as much as 800 seers of paddy seed to the acre. A sharp struggle for existence then ensues and the plants that arise show but a few inches of growth above ground. They stop there in a pale yellow condition waiting for the transplanter to relieve them of their congestion. Small wonder that these weak seedlings are after transplantation washed away by the monsoon water that gushes through the fields almost in streamlets! They have thus to be stuck into the land in clusters of 40's and 50's. Their lot is not very much improved by their transfer from the nursery to the field. Other circumstances also favour this thick planting.

Large bundles of seedlings are generally carried to the field and many a time the men are paid by the number of bundles they use up. This ought to and does afford a nice premium to increase the number of seedlings in each cluster to as great a figure as possible. Handfuls are taken at random and are dibbled into the swampy land.

The paddy plots not being quite level, by the time the top gets enough moisture, the lower side will have more than eight inches of water. Single weak plants will not have enough stamina to stand upright and hold their head above water. They soon lodge, sink under water and rot; clusters on the other hand, withstand the force of water like the "faggots in bundles." and grow up as usual. Another enemy *viz.*, the crab steps in at this stage and does its portion of the damage. Fortunately hongey (Pongamia glabra) oil-cake has been found a ready panacea for this woe. By its application, the crabs soon die and begin to float to the surface. I have since heard it said by many of our intelligent (nay reliable) co-operators that any other cake—be it, safflower or ground-nut—will act with equal efficacy on the vermin and kill it. If this be true, we shall be one step nearer to the solution of our difficulties in the way of introducing economic transplantation. Again to give an easy run off to the excess water, the plants have to be a bit further apart, say at least 9 inches to a foot. Planting them at distances of six inches as we do in a rainless country will certainly stem the current of water and thereby bring about an undesirable uprooting of the plants. In a poor unmanured malnad soil from which the pelting rain washes down the plant food year after year, single plants transplanted a foot apart will not put forth many tillers and produce a decent or profitable crop.

So much in favour of the system of cluster planting which has built around itself an impregnable fortification. Our attempts at introducing economic transplantation have therefore found insurmountable opposition and our progress has indeed been as slow as that of a snail. To begin with, let me hasten to say that our repeated and many preachings have told on the prejudice of many intelligent cultivators who have now reduced the number of seedlings from 40's and 50's to 10's. Even 4's and

5's have slowly crept in wherever manure is plenty and seedlings are plump and well-grown. Why! A cultivator that chooses his seedlings from among his dry sown paddy fields knows the benefits of economic transplantation too well and hardly uses more than 4 or 5 for each dibbling. A moral can at once be drawn from this. Just as the paddy is broadcasted thin in dry fields, so must it be sown thin in the nursery beds as well. Instead of 800 seers, 100 or utmost 150 seers should be the seed rate even for nursery beds. These should be manured and cultivated well to force up the growth of the seedlings. If by these means, thick and vigorous seedlings of more than one foot in length are produced, all objections against economic transplantation will vanish. Single seedling transplantation is out of the question for some time to come in the malnad. It is enough for the present if we can bring down the number to 2's and 3's. These big seedlings will not get submerged in the irrigation water and will be able to stand the force of its current. The use of oil-cake will come against the ravages of crabs which are destroyed by it. This manure together with some phosphatic fertiliser like superphosphate or bone-meal will also make the paddy tiller well and produce a good crop. This will face the last of the problems *viz.*, that their planting at distances of a foot or so will not result in a profitable crop. It has now to be ascertained what quantities of oil-cake and bone-meal or superphosphate will be financially successful consistent with their prices which have of late risen high and are rising still higher. I have this year recommended a dose of 5 maunds of cake and 5 maunds of superphosphate per acre. This will cost about Rs. 14. The paddies treated with this mixture are looking exceedingly nice. The Agricultural Inspectors of the Western Division have fertilizers ready for sale at their respective depots. The enthusiastic cultivators will do well to purchase the same and try them on their paddy.

The advantages of economic transplantation are manifold. In the first place there is a large saving in seed. Having enough space and food, the seedlings will have vigour, tiller well and develop good and long ear-heads. The yield of grain will be decidedly more,

Advantages of Good Cultivation in Cocoanut Gardens and its effects during Seasons of Drought

BY

S. K. Palaiyengar,

Passed student, Mysore Agricultural School, and Landholder, Mysore District.

VERY few people seem to have realised the importance of good cultivation and its advantages in a cocoanut garden. Here I give an account of a cocoanut garden which was kept in a bad and neglected condition and how it was improved and made to bear good fruits after good cultivation was given to it and by a study of the result we can see the advantages for ourselves. The trees in this garden had a very stunted growth, the branches drooped, the colour of the leaves was pink, the crown of the trees turned to the ground and in some trees only the stem stood without any branches and some more trees appeared to die. The whole garden was thus in a very deteriorating condition. The reason for this was that the whole garden was full of weeds and the soil was so hard that it appeaned to have received no cultivation for the last few years. In most of the trees roots had come near the surface and also many rootlets branched very near the surface thus exposing themselves to the heat of the sun. Only a few trees were bearing fruit and the size of the cocoanut was very small. The crop became reduced by the dropping of the immature nuts. The experiment to improve this garden was begun in the year 1915. During the early monsoon the whole garden was given good and deep ploughing. All those roots and rootlets which were very near the surface round about the stem of the tree were pruned to encourage the growth of the roots and rootlets below the soil so that they may not be affected by the heat of the sun and dryness of the soil mulch and the earth was mounded up round the stem to a height of a foot or a foot and

a half. After every rain when the garden was in a suitable condition to be ploughed a good ploughing was given and in the course of that year several ploughings were given. All the weeds were collected and thrown out. This operation was done to improve the texture of the soil; and to well ærate the soil; the deep ploughing does not only place at the disposal of the crop more plant food but also makes roots go deeper and deeper. The very same year, a few months after this operation the garden showed a considerable improvement. All the trees that had a gloomy look, put out green leaves and the branches were erect instead of drooping as before. The garden showed signs of improvement in all respects and the trees began to bear larger number of fruits. This we can see by comparing the figures I have given below for the three years. The same operation *i.e.*, good ploughing and weeding and soil mulching was given next year also *i. e.*, in the year 1916 and is being continued every year till now. The garden which was then considered to be a failure has now proved to be a successful one yielding fairly good crops. Now let us compare the figures. In the year 1915 before any cultivation was given the average number of fruits per tree was about 15. After it was given cultivation in the year 1916 the average yield per tree was 30 and in the year 1917 the average yield was 38. So by these figures we see that there is a gradual increase in the yield. In 1918 the yield fell to 34; this year was one of poor rainfall and I do not think it weakens the force of my conclusion. There is little doubt that cultivation of cocoanut pays, and every planter will find its benefit whenever the cultivation is carried regularly. The main object of cultivation should be to accumulate as much of water as possible by giving deep cultivation, to well ærate the soil, and keep it free from weeds so that the whole plant-food available in the soil may be made use of by these plants. When these operations are done there is certainly no doubt for the success of a plantation. Those who put a plant in the ground and expect nature to do the rest of the work cannot expect to be well paid in return.

Now coming to the question of drought, the cultivation described above is not only beneficial to the success of a plantation

but also it maintains the garden in a fairly good condition during a time of drought. This fact is well experienced by us all for the last two years on account of the scarcity of rainfall. But for the practice of dry-farming *i. e.*, tilling the ground during dry weather, and thus increasing its water holding capacity and thereafter conserving the soil moisture by means of mulching and clean weeding, the whole garden would have deteriorated again. This difference can be seen by comparing the gardens that were given regular cultivation and careful attention with that of the garden that was cultivated indifferently.

The latter garden suffered heavily during these two years. The crop was very low by the dropping of the immature nuts, branches drooped and the leaves were pink. Those which were cultivated were fairly good and yield also better though not so much as in the years of good rain-fall.

It is well known to every gardener that when the weather is dry he should pay attention to keeping the surface of the soil in good tilth to preserve the soil moisture and to deep cultivation to encourage deep rooting of plants and to allow of whatever rain that falls to penetrate the soil readily. It is very important to see that the plantations are always kept prepared to fight the drought.

The Marthur Farm, Shimoga District.

BY

M. J. Narasimhan, B. A.,

Assistant Botanist, Mysore Department of Agriculture.

THE Marthur Farm, situated on the Shimoga-Honavar road, and nine miles away from Sagar, was started with the chief idea of investigating into the conditions of cultivation of the garden crops, such as areca, pepper, cardamoms, *etc.*, as well as the other crops, grown in the Malnad. The scope of the Farm is very great, as many new, desirable varieties of crops, suitable to the Malnad areas, may be first experimented with on the Farm before they can be safely recommended to the people at large. Visitors to the Farm, interested in agriculture should pay particular attention to many of the interesting experiments, carried out with special reference to conditions obtaining in the Malnad. The chief interest lies in the areca garden, the sugarcane and paddy areas, the dry crops and the orchard, all presenting a picturesque view, with the background of a hill, when seen from the Talaguppa valley.

The areca garden.

The garden, consisting of 5 acres and 19 guntas was not in a very good condition, when it was first taken up by the Department, owing to lack of proper cultivation, but has since, considerably improved in appearance, and in the general vigour of the plants. The chief crops found in the garden, are areca, pepper, plantains and cardamoms. A portion of the garden is reserved as a nursery for areca seedlings. A selection of the local varieties has been made, according to the size of the nuts, and sown in three different lots, as small, medium, and large. After one year, the seedlings are transplanted, near to the trench, which runs from end to end of the garden, between every two rows of areca trees. Varieties of nuts from Barathipur, near Thirthalli, which are small in size, and are said to be high-yielding are also being tested in the nursery. Apart from these, the varieties from

Kalasa, are being grown, since the areca trees at Kalasa, have been found to be quite immune to the attack of Koleroga, and it is expected that the offsprings may prove disease-resistant, too.

Manurial experiments with areca have also been started to test the efficacy of these against that of the local method of

Marthur Farm—Arecanut area showing the large drain.

manuring. This latter, consists in spreading a layer of green leaves, and farm-yard manure, all over the garden, once in three years, just after the heavy rains during September, sometimes during June also. The usual practice, with the garden-owners, is to take up a third of the garden every year, for manuring in this way. On the Farm, experiments have been detailed out to try the effect of different kinds of manures, in addition to the green leaves, successively for a few years. The different manures that are tried are, fishmanure, oil-cake, potash, oil-cake and

superphosphate. One series of experiments was set apart to test the effect of these manures, with lime in addition.

The effect of green manures also is being tried. Between the rows of areca trees, is grown, *Crotolaria striata* (Kanarese; Kaisanabu), a Leguminous plant, growing generally to a height of four feet, but often reaching up to six feet in the shade. The plant is cut down in August, and applied as green manure to the areca trees. The plants occur all over the Farm, in the wild state, and are used for collecting the seeds for the next season.

Marthur Farm—Spraying for Koleroga.

Experiments have also been tried, with regard to the Koleroga disease of arecanut. The standard solution of the Bordeaux mixture, that is being used, successfully, in combatting the disease in the Malnad parts, consists of 5lb copper sulphate, 5lb lime, 2lb resin and 1lb soda, in 25 gallons of water. It was decided to see if a weaker solution, consisting of various proportions of the ingredients, which are reduced to half the quantity, or in some cases, omitted, will not answer our purpose in checking the disease to the same degree as the standard solution. It was found that the disease had been breaking out

more often in the areas, sprayed with weaker solutions, than those done with the standard mixture.

Pepper varieties are also being tested, to see if some of the introduced varieties, cannot well replace the local varieties. The varieties that are being tried are the local varieties, the

Marthur Farm—Arecanut area showing heavy growth of green manure crops.

Sorab varieties, the Siddapur varieties, and the varieties from the Taliperamba Pepper Farm. in Malabar. The vines have not yet been bearing, but some of the Malabar varieties, such as *Balam-Kota*, and *Kaluvalli*, seem very promising.

Plantain varieties, such as the local ones, and those introduced from Poona are in very good condition. In the case of the loeal varieties, earthing up of the plants seems to have made the plants bettter. Cardamoms are grown on a very small scale.

Paddy

The area under paddy cultivation is 9½ acres. Varietal tests have been carried on with paddy, mainly to see, which of the varieties, give a high yield. It was found that some of the varieties. such as the local *Jadda, muslli, wallya* and *mullage,* are particulary good yielders. The varieties from Malabar, made a poor show in the Farm, as they were poor in the number of tillerings, and ready for harvest rather early in the season. Varieties from Kadur and Hassan are also being tested. The bulk paddy expriments are being carried on in 10 gunta plots, in some cases, the paddy being sown behind the plough, and transplanted in the others. The paddy is being rotated with sugar-cane.

Sugar-cane.

The varieties introduced are mainly Red Mauritius, Java, and the Hebbal varieties. Owing to the heavy rains, in the Malnad areas, producing a water-logging condition, a trench 1½ feet deep, and 1 foot wide is dug out between the rows. Experiments were tried with Red Mauritius, planting the sets in double rows, allowing a space of 4 feet apart from trench to trench. This method has proved superior to that of having a single row, with a space of 2 feet between the trenches.

Manurial tests were also tried on a small scale with Red Mauritius. Manuring with oil-cake at one ton per acre seems to have better effect on the cane than manuring either with Farm-yard manure or oil-cake and superphosphate together. Of the Hebbal varieties introduced H. 315 has done quite well producing a large number of tillerings. Varieties of turmeric from Poona are also being tested.

In the dry area Ragi, chillies, horse-gram and groundnut are sown. The locally selected Ragi. of the Jadesangha type seems to have done the best on the Farm. The chillies gave a very large yield last year, some of the best among them being the Malabar varieties and the locally selected ones.

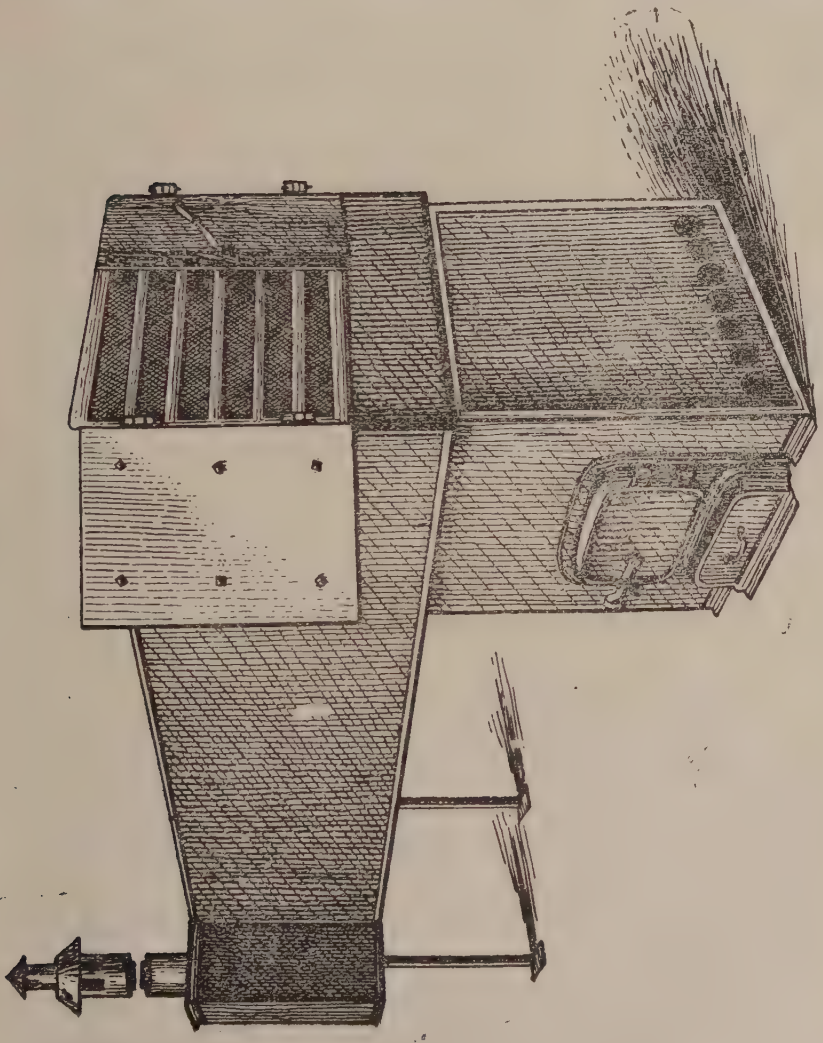
The Orchard.

The introduction of fruit trees in some of the Malnad areas is one which can be profitably attempted. Attempts are being made to find out the possibility of growing a number of fruit

trees on the Farm. Among these mention must be made of the luxuriant growth of the orange trees. Pomegranate, apples, of the "*Rome Beauty*" variety, and mangoes of different varieties have been successfully introduced. Horse-gram is being tried as a catch crop between the fruit trees in the Orchard.

The Areca Drier.

An areca drier imported from the Tyneside Company in America, has been working satisfactorily. The drier is made of



The Arecanut drying furnace on the Marthur Farm.

plate iron, with a furnace at one end, the heat being conducted by means of a central pipe, running all along the length of the drier, the smoke escaping through a chimney. Over the central pipe, is situated the drying chamber, in which are placed, one above the other, four layers of trays made of expanded metal. After this model, has been constructed a structure made of laterite stone-work, using a central flue made of tin. This has been working very satisfactorily, and can be constructed to the size needed by the areca garden owner. The advantage of the drier lies in the fact that the garden owner need not be depending on the sun for drying the nuts as is usually the practice. The danger of smoking the nuts on *thatties* or mats, over a fire is very well known. As a matter of fact, many of the bunches come to maturity during the rainy season and become over ripened or "*gotu*", which has, practically, to be discarded. These can be dried in time, in the drier, along with a large quantity of plantains, and jack-fuit obtained in this season. The colour of the nuts thus dried, is quite good. The drier, as locally constructed, is attracting the attention of the public, owing also to the short course held at Marthur to demonstrate its use. Applications are also being received from various leading garden owners for constructing driers on their estates. The drier, as it is, is far from perfect, and there is considerable scope for improvement.

Silo Pit.

The wealth of the pasture lands in the Malnad can be better utilised by means of this kind of cheap structure. Large quantities of grass can be well preserved for use, during summer, for the cattle. On the Farm, a pit, 14 feet deep, and 10 feet in diameter, was dug out in a dry area, completely filled with grass, and sealed up with dry earth, heavy weights being placed over it. The grass must be cut about September before the grass flowers. It is better to dig out a shallow trench round about, such that water may not get into the silo pit, nor percolate into it. The grass is well preseved and fresh, when the pit is opened during summer, and is much relished by the cattle.

Among the Farm Buildings, there are the office buildings, night school, short course rooms, cattle shed, jaggery boiling

shed, seed storing room, where the seeds are stored in large bins of galvanised iron, and the Farm Manager's quarters. The water-supply for the crops on the Farm is by means of a tank and five wells dug out in various places.

The Farm Manager will be always at the service of visitors, interested in agriculture, and gladly give any advice they require of him. The dates of the various short courses to be held on the Farm are announced in the *Mysore Gazette* and in the Vernacular papers.

Fordson Tractor Ploughing at Gangenhalli.

A Note on the Working Costs

BY

A. Mac Isaac,

Gangenhalli Estate, Tavarekere P.O., Bangalore District.

A field, 3 acres in extent, roughly oblong in shape and sloping was ploughed to a depth of not less than 8 inches in 4½ hours' time. The state of the land was favourable for ploughing but while about a third of it was covered with uncut 'juari' the rest was covered over with long grass and jungle. The soil in parts was a heavy, sticky deep-red loam and in others sandy, and the sub-soil which was turned up was a stiff red loam. The ploughing was done across the slope and the 'juari' and jungle were fairly well buried.

On the following day horse-gram was sown and the field was harrowed over twice in 4 hours with a toothed chain harrow, worked by one man and a pair of bullocks.

COST OF PLOUGHING 3 ACRES.

	Rs.	A.	P.
8 gals. Gold Mohur kerosine oil consumed including going to and coming from the field	7	6	0
½ gal. "A" oil for lubricating ...	1	8	0
Grease and gearing oil	0	2	0
Driver's pay at Rs. 40	0	10	8
One coolie at Rs. 7-8	0	2	0
Depreciation	1	10	8
Total ...	11	7	4
Cost per acre for ploughing ...	3	13	1

NOTES AND COMMENTS

By the Editor.

Our Members and their Work.

We are glad to note that four of our members Messrs. H. Srinivasa Rao, M. Subba Rao, L. S. K. Palaiyengar and A. Mac-Isaac have contributed to the current number. All four articles relate to experimental and other work, conducted by them on their estates which they themselves directly manage. We have also received similar articles from other members which we have had to hold over for the next number. The Editor regards all such contributions as singularly valuable; for the results of the experience of Indian farmers on their own estates scarcely ever appear on the printed page: they seem to be proof alike against the enchantments of the wiliest Editor and the attractiveness of the best conducted journals. Our Journal is mainly intended to record members' work of this character and we trust members will help us to extend this unique and useful feature of our Journal.

* * *

School of Tropical Agriculture, Ceylon.

We have often received inquiries from both parents and students regarding the working of the Tropical School of Agriculture, Ceylon. In our "selections" we have extracted a report on the working of the school for the first complete school course i.e., from May 1917 to March 1919. The report gives a full account of the kind of instruction that can be had in the school and we hope readers will find the information useful.

* * *

The Profits of Farming.

Mr. M. Subba Rao's account in the current number of the profits of his farming is sure to elicit criticism from many quarters. He has opened up a subject which in a country where the State derives the bulk of its income from a share in the produce

of the land is of perennial interest; it is a subject nevertheless in which few people like to face the truth. The truth in this particular case is hard in all conscience; for the income from this farm amounted to only $4\frac{3}{4}\%$ on the capital invested. No remuneration to the farmer is included in the account, that is to say, if interest on capital is charged even at this very low figure, "the labour income" of the farmer is nothing. The land can be leased out so as to yield this interest or the capital altogether withdrawn from the land and invested in other equally safe concerns guaranteeing this rate of interest. The farmer will be free in either case to employ himself in other ways and earn an income over and above the interest which his capital is earning simultaneously without any effort on his part. We do not wish to go into this aspect of this matter at this stage for we hope to be able to publish accounts from many more farmers, when we shall be in a safe position to draw conclusions. We may point out however that a detailed account of this nature will reveal in what respects the various operations can be carried on differently so as to cheapen cost or increase the money return from the business. We shall be glad to publish practical and well-informed suggestions or criticism in this regard.

* * *

Tractor Ploughing and the "Sabool" Plough.

In our correspondence pages, Dr. Leslie C. Coleman criticises certain statements made by the Agricultural Engineer, Department of Agriculture, Gwalior State, regarding the merits of Traction ploughing as compared with bullock ploughing which we published in the last number of this Journal as 'extracts' from the Annual Report of that Department. The reply of Mr. David Griffin, Agricultural Engineer, is also published along side. Apart from the question of traction ploughing which comes in a class by itself the matter of devising an "improved" plough suitable for bullock draft is a very important matter; many excellent patterns of such ploughs already exist among the types now on the market both in India and in the United States of America, but no one can deny that even the best of them is capable of improvement, in the matter of their suitability to

Indian conditions. These conditions themselves are very varied both in respect of the size of the bullocks in common use in the different tracts and the different types of soils prevailing, with their varying requirements as regards the design of the plough and wearing quality of the material.

The Mysore Department of Agriculture has always been keen on the question of improved implements. Certainly more of these ploughs have been sold in the State proportionate to its area than in any other province in India. A number of types of imported ploughs have been got out and tested. There has been commendable enterpise in the local manufacture of ploughs, plough shares, share points and other accessories. New models are being devised. It is not mere local patriotism therefore which makes us state that Dr. Coleman's opinion regarding the "Sabool" plough should receive great weight. Possibly the range of country traversed by Mr. Griffin extensive though it is, has not embraced the land of plough bullocks of the type to be seen in Mysore. The conditions however are sufficiently varied, as we already observed, to admit of a fair diversity of types of ploughs and it will be impossible to generalise as to the merits of any one of them.

* * *

The Indian Sugar Committee.

We understand that the Sugar Committee appointed by the Government of India has included the Mysore State in their itinerary. The Committee is to inquire into all aspects of the sugar question with a view to encouraging the manufacture of sugar on a large scale in India and to help her to produce at least a portion of the large quantities of sugar she imports from abroad every year. The terms of reference to the Committee, which we print among our "selections" are, it will be seen, fairly comprehensive in their scope. The Committee will receive a warm welcome and we hope that their labours will be fruitful of much good to the State.

* * *

Sugar and Japanese Enterprise in the Far East.

The magnitude of the efforts we shall have to make if we have to keep out foreign sugar and the nature of the colossal or-

ganisations that are gathering together to capture the sugar trade of the Far Eastern markets will be realised from the following extract from one of the leading English sugar journals.

"An American contemporary has lately collected further details regarding the extension of Japanese schemes of sugar industry in the Far East which are illustrative of the manner in which the Japanese are bent on making sugar production one of their greatest enterprises. Japanese capital encouraged by the high degree of prosperity which has followed upon the development of the Formosan sugar industry is seeking for further opportunities, and so has turned its attention to the Dutch possessions in the East as a promising field. Thus, a Tokyo syndicate with a capital of £600,000 has after preliminary investigations acquired three plantations totalling 20,000 acres in the province of Surakarta; these formerly devoted to coffee and rice will now be planted to cane. But more significant is the fact that this and other Japanese companies have been making investigations in Northern Dutch Borneo and in Sumatra, regions where cane-growing has not hitherto been undertaken and are seeking for concessions in land in both these territories. They are also extending their operations into Sarawak, where one company has recently acquired 2,800 acres of land and is negotiating for 25,000 acres more, and another has obtained 1,500 acres. Simultaneously with these plans extended services of Japanese steamship companies are projected between Japan and the East India, and British India and New York, with the principal purpose of carrying sugar from Java to British India and gunny from Calcutta to New York. Vessels of 5,000 tons will be employed and thanks to Japan's present mastery in the Pacific her carrying trade in that ocean is bound to be considerably augmented in the near future.

Besides Japanese companies, the formation is reported of an Anglo-American Syndicate with a capital of £2,000,000 to develop sugar and other industries in Sumatra. A well known Java planter is now in Sumatra as the syndicate's agent to investigate and report on possibilities.

It is clear that Japanese competition is going to be a serious factor in the sugar trade in the East; primarily the Chinese

market will be the aim of the sugar producers, but thanks to Japanese efficient mercantile marine (which has probably suffered least of any from the ravages of the War) there is no reason why her sugar should not enter markets all over the world one day, and compete with the older established sources of supply. Next to China, Japan will assuredly enter into competition with Java to supply the India market, and the Calcutta Government will have to consider before long how far this competition can be allowed to run unchecked at the expense of the native Indian industry. The latter is faced with more competition than ever, and what is worse, competition of a very high technical order, since the Japanese industrialist leaves no stone unturned to obtain the most efficient plant and employ the most up-to-date methods of production.

We cannot help calling mind in this connection the scene we witnessed in one of the largest sugar machinery works in Glasgow nine years ago where a giant 14 roller sugarcane mill with the other component parts of the machinery and plant on the same scale of a sugar factory were assembled together prior to shipment to Formosa to a Japanese sugar company. A similar plant was said to have been already shipped to the same destination. The plant was certainly of the most efficient type known. The methods of cultivation have been designed and are being carried out so as to secure the highest yields of cane that the climatic conditions would allow, while the land tenure has been so arranged as to ensure to the factories a regular supply of cane and to absolutely forbid any private milling of cane so as to prevent the loss that primitive small scale mills imply.

* * *

The Composition of Buffalo Milk.

The milk of the buffalo is known to be very rich in fat, but at the same time in South India at least there is a belief that it is not as wholesome as cow's milk. People in this part of the country would not if they can help it use buffaloes' milk at all, wherever the milk is required to be used as such and not for conversion into curds, butter or ghee. Even in the case of these latter, the cow is supposed to yield more wholesome products than the

buffalo, and in the case of children or convalescents buffalo milk and milk products are strictly avoided. The following extract however takes a contrary view ; but it will nevertheless be found interesting.

In Zeitschrift fur Fleisch und Milchygiene, September 1918, G. Tartler recommends the raising of buffaloes as dairy animals, on account of the nutritive value of their milk, as well as their resistance to tuberculosis. This immunity of buffaloes to tuberculosis renders their milk particularly suitable to consumptives. Buffalo milk has higher percentages of fat and albuminoids than cow's milk ; this is true also for calcium and phosphoric acid content. Analysis of buffalo milk made by the author show; specific gravity 1·0333, water 81·94 per cent, dry matter 18·04, fats 9·07, total albuminoids 4·42, casein 3·54, albumen and globulin 0·50, lactose 5·19, ash 0·883. The ash contains: potash 13·33 per cent, sodium 8·17, lime 33·51, magnesia 3·75, chlorine 9·19, phosphoric anhydrid 33·50.

The author also states that buffalo meat is more rich in iron than is beef, and that it makes excellent building food for convalescents.

* * *

The Use of Sugarcane Trash as Manure.

The trash of the sugarcane, *i. e.*, the dry leaves which are stripped from the sugarcane when the crop is harvested, is usually put to no better use than as fuel at the jaggery boiling furnace. In the Manjri Sugarcane Farm it has been used as manure on sugarcane fields being made to serve the purpose of an ordinary bulky organic manure, and its effect has been compared with that of cattle manure. The results of seven years' trials are reported in the "Work on the Manjri Farm for the years 1915—18" published by the Bombay Department of Agriculture.

Farm yard manure was applied at the rate of 30 cartloads per acre on the check plot and sugarcane trash was ploughed in such quantity as to supply 10,000 lbs. of dry matter per acre.

The average yield of cane and jaggery per acre for the 7 years from the two plots is given below :—

	Farm-yard manure.	*Sugarcane trash.*
Cane per acre.	83,967 lbs.	75,077 lbs.
Jaggery ,,	10,692 lbs.	10,002 lbs.

The financial aspect of the experiment is summarised below :—

	Rs.	A.	P.	Rs.	A.	P.
I Farm yard manure ...	60	0	0			
Spreading ...	0	12	0			
				60	12	0
II Trash :—						
10,000 lbs. of dry matter. (Fuel value) ...	12	0	0			
Carting	1	2	0			
Ploughing under ...	8	4	0			
Putting in furrows ...	1	14	0			
Rolling and harrowing	2	1	0			
				25	5	0
Balance in favour of trash . .				35	7	0

The report states " This balance far more than makes up for the deficit in yield found in our average results." It should be added that the soils of the Farm are of the heavy black cotton soil type.

CORRESPONDENCE.

THE EDITOR,

Journal of the Mysore

Agricultural and Experimental Union,

Bangalore.

DEAR SIR,

In the last number of the Journal I have noticed with much interest an account of ploughing trials carried out by the Agricultural Engineer, Department of Agriculture, Gwalior.

The figures of comparative cost for ploughing with country plough, and the Rajah and Sabul ploughs drawn by bullocks on the one hand and for tractor ploughing on the other are interesting but are I believe open to criticism, more especially with regard to the question of depreciation charges. I shall however not discuss this subject here as it seems probable that depreciation charges are placed too low in all the cases given.

Let us examine the results. The cost per acre as given is as follows:—

		Cost of ploughing per acre. Rs. a. p.
1.	Country plough	2 0 9
2.	Rajah plough	1 13 2
3.	Sabul plough	1 15 3
4.	I. H. C. 15/30 H. P. Tractor and plough	5 15 9
5.	"Mogul" Tractor and plough ...	4 2 6

If we compare the cost of ploughing with a Sabul plough on what is stated to be heavy soil with that of the more favourable tractor plough under what are stated to have been ideal conditions we find that the latter has cost over twice as much as the former.

The Engineer says in conclusion:—"The above figures speak for themselves. However, it must be remembered that

one ploughing with the Tractor is better than two with the Rajah or Sabul and twenty with the country ploughs. Hence for good, quick, efficient work, the oil Tractor has the advantage".

I must take strong exception to this paragraph. Knowing as I do the Sabul plough and its work and having seen a fair amount of tractor ploughing I am prepared to state that for ploughing under ordinary conditions the Sabul plough drawn by bullocks will do just as good as if not better work than that done by any Tractor plough. The erroneous view that there is some special virtue in having a plough drawn by a tractor rather than by bullocks should be combatted most vigorously. It should be evident to any one that the efficiency of a plough does not depend upon the power which draws it but upon the design of the plough. It should be equally clear that straighter and better ploughing can be done with a plough directed by handles or stilts than with a plough guided by a pair of wheels as is the case with nearly all tractor ploughs.

It is no doubt true that with a Tractor one can use a much heavier and bigger plough than is feasible with bullocks and that with such an implement much deeper ploughing can be done.

It is a not uncommon impression that deep ploughing is alwayas advantageous but there is I believe absolutely no foundation for this view. Under certain conditions deep ploughing is undoubtedly beneficial. Thus where we have to do with deep rooted weeds it is essential to plough deep if we are to uproot them. It is for this type of work that tractor ploughing will undoubtedly find its greatest use in India in the immediate future.

I am not prepared to state that this is the only place where tractor ploughing can be advantageously carried out. There are undoubtedly other uses to which it can be put such as for bringing into cultivation large tracts of land, in areas where labour is scarce. I do not believe, however, that tractor ploughing can under ordinary circumstances compete with ploughing with a well-designed improved plough drawn by bullocks either as regards cost or efficiency of work. There is scope for the Tractor in India but a very poor service is done to Indian agriculture by

issuing erroneous statements with regard to the superior quality of work done by a tractor plough. As a matter of fact ploughing itself is but a cheap substitute for hand digging which is the best way of preparing land known.

Yours faithfully,

LESLIE C. COLEMAN,

Director Agriculture.

REPLY

To

The Deputy Director of Agriculture,

Mysore State.

DEAR SIR,

I have to thank Dr. Coleman for his criticism of my report on 'Tractor Ploughing' for it opens the technical side of a problem that cannot be well handled in an annual report.

Obviously there is no special virtue in having a plough hauled by a tractor. The virtue does not lie in the prime mover but in the manner in which the power is exerted. Regardless of the type of plough it will not do good work unless pulled at the proper speed. You may have noticed that, if when ploughing the bullocks became suddenly frightened and made off at a speed of five miles per hour the furrow slice was thrown over and beyond the next adjacent furrow that had already been ploughed. What does this mean? Simply that that individual plough was not made to plough at a speed of five miles per hour.

Now the Sabul Plough is the best bullock drawn plough that has yet attracted my attention in India but it has its shortcomings.

It does its best work and at a speed of about two and three-fourths miles per hour. Thus when pulled by bullocks that move at a pace of one and a half to two miles, under load, we find that it does not turn a clean furrow because the curve of the mould-board is not sufficient. Further, the share does not cut the whole width of the furrow slice; hence, many weed roots escape untouched at a single ploughing.

Should this plough he pulled by horses as has been done at some of the Remount Depots, at the constant speed for which it was designed, it does an admirable job of ploughing, but bullocks do not walk at that speed.

When we use a tractor it is generally supposed that we use a plough especially designed for the speed of that tractor. The design of this plough will not only determine its efficiency but the kind of work that it will do. If a plough moves at a high speed it requires both less 'toe'and 'suck' to keep it in the ground and 'running on an even keel' than if moving at a low speed in the same soil.

'Toe' is the term used to represent the angle of divergence of the point laterally from the face of the landside. Hence the point partially counteracts the side thrust of the soil as it is lifted and turned by the mould-board thus keeping the plough in a straight line.

'Suck' is the term used to represent the angle of divergence of the point downwards from the plane of the lower edge of the landside. The point thus helps to hold the plough into the soil.

Technically 'toe' is defined as the lateral distance from the angle formed by the share and landside (where they meet) to a straight line connecting the heel of the landside and the point of the share.

'Suck' is the vertical distance from the angle formed by the share and landside (where they meet) to a straight line connecting the heel of the landside and the point of the share.

On a properly constructed plough, therefore, the point is neither in the same vertical plane as the face of the landside nor in the same horizontal plane as the lower edge of the landside.

The Sabul Plough has both 'toe' and 'suck' and its best feature is that both are adjustable to different speeds and soils but the mould-board which is made for a higher speed than bullocks usually travel does not throw a clean furrow.

In the U. S. A. with a good team of horses I could do a better job of ploughing with a walking plough than with a tractor but neither so cheaply nor so quickly. A few years backed

by about sixty thousand miles of travel in India have as yet failed to show as good a job of ploughing by bullocks either as to straightness of furrows, or as to clean cut and turned furrow slice as was made by the tractor at our tests in 1917 on the Central Farm at Lashkar, the conditions of which you will have noted in the report were 'ideal'.

There was no intention of giving an erroneous idea as to the advantages of tractor over other forms of power but in so far as the tractor gives us an abundant and even flow of power such as is admittedly requisite for good ploughing it, to-day at least in this part of India, has the advantage over other sources of power. It would appear that the criticisms noted in this article may have been brought forth. not due to the inability of the tractor to do a good job but that the operator was not sufficiently acquainted with his work. A tractor will not run in a straight line of itself but it surely requires only slight practice to learn to guide properly. Then too there are self steering gears for many tractors so that a straight guide furrow is all that is required and after that has been made the tractor will follow it absolutely.

However the fact that the tractor meets this need is in a way to be regretted for it cannot attain the prominence and popularity in India that it has in Europe and America. The bullock is bound to remain the motive power in Indian agriculture for generations. Hence it behoves the Departments of Agriculture and Agricultural Engineering established in the various parts of India to develop and perfect implements of such type as will perform the required cultural operations with the power available. They should import implements of foreign types only to the extent that these satisfy the requirements of the cultivator or bridge the gap until the time when the authorities responsible can develop such implements as are specially required.

The future of Indian Agriculture depends upon the steps taken in this direction in the next two decades. On account of the industrial activity the producer must be equipped with some means of increasing the production per producer. The villagers are migrating to the industrial centers. The number of consumers thus remains constant while the number of producers diminishes.

In order to put at the disposal of the ryots in Gwalior those implements out of the reach of the ordinary cultivator a separate budget has been granted for giving on hire at moderate rate such implements as are particularly useful. The more complicated implements will be operated by trained men.

In addition a new scheme of 'hire purchase' is being adopted whereby the amount received from hire, if so desired by the ryot, may be credited towards purchase of the machine he may be using.

We are awaiting with interest the results of this novel scheme.

Sincerely yours,
D. W. GRIFFIN,
Agricultural Engineer,
Gwalior State.

SELECTIONS.

I

The Indian Sugar Committee.

The following are the terms of reference approved by the Government of India in connection with the *investigation of the Indian sugar problem*, entrusted to a committee, presided over by Mr. James MacKenna, C. I. E., I. C. S., Agricultural Adviser to the Government of India:—

(1) "To examine the various sugarcane-growing tracts of India with a view to determining the nature of the expansion possible in such tracts either by the development of a factory industry or by improvements in the existing indigenous methods; (2) to examine the possibility of consolidating the areas under cane and of the extent to which this is limited by the existing systems of land tenure; (3) to report on the work already done by the sugar expert with regard to the breeding and selection of improved varieties of cane and to make suggestions as to the extent and direction in which this work can be further expanded; (4) to examine the present methods of co-ordinating work on sugarcane adopted by the Agricultural departments working in the various provinces and the efficiency of agricultural practice in vogue in India or recommended by the Agricultural Department; (5) to examine the existing sugar factory industry in India and to advise in what localities and under what conditions a factory industry can be successfully established; (6) to examine the economic and labour conditions now prevalent in the various districts where expansion of the sugar industry is likely and the question of improving railway facilities and other means of transport which may be required with a view to furthering the spread of the industry; (7) to investigate the work that is being done in the introduction of improved small power plants and small power factories; (8) to review the position of India with regard to the world's sugar supply and to formulate recommendations for the improvement of that position; (9) to investigate the conditions under which refined and raw sugar and molasses are imported into India; (10) to examine the effects of controlling such imports by a duty, and where necessary, grading this duty so as to give preference to sugar grown in British dependencies; and (11) to examine the present conditions governing the manufacture of rum under licence from Government and the question of distributing such Government contracts."

II

Certain Aspects of the Organization and Policy of the Agricultural Department in Bengal.

A Resolution, dated 7th June 1919, issued by the Government of Bengal, says :—

As it is desirable to place the public in possession of the intentions and policy of the Agricultural Department in the Agricultural development of the Bengal Presidency, the Governor in Council deems it advisable to explain in some detail certain aspects of the organization of the department, together with some suggestions derived from the experience of other countries as to how the people can best benefit from its activities.

The necessity for private effort.—The two main branches of the department are the research and demonstration branches. It is, however, clear that the activities of the department in respect of the demonstration of the results of the investigations of the research branch cannot be expected to reach more than a fringe of the agricultural population without the help of the public. On the one hand, the extent of such activities is conditioned by financial considerations: on the other hand any development of the kind is of no avail if the people are not ready or cannot arrange to take advantage of it. Individually the agriculturist is ready: experience in this country has shown that if he can see with his own eyes the value of an improvement he will adopt it. But if all are to benefit, experience in other countries shows that the agriculturists must meet Government half-way in the matter. It has been found in those countries that, if small associations of agriculturists are formed to test and adjudicate on suggested improvements, to discuss their successes and failures with each other, and to bring their needs to the notice of the Agricultural Department, then not only is the practical problem of how to reach the whole agricultural population solved, but there is hardly any limit to advancement in the direction of improved production, economic distribution, improvement of breed, and indeed in all mental and moral development. In the words of an American Professor of Political Economy, Dr. J. A. Ryan, "The transformation in the rural life of more than one European community through co-operation has amounted to little less than a revolution. Higher standards of agricultural products and production have been set up and maintained, better methods of farming have been inculcated and enforced, and the whole social, moral and civil

life of the people has been raised to a higher level. From the view-point of material gain, the chief benefits of agricultural co-operation have been the elimination of unnecessary middlemen, and the economies of buying in large quantities, and selling in the best markets, and employing the most efficient implements."

An essential condition, however, for the success of such associations is that they should be conducted on the basis of self-help. It is desirable for Government to assist such associations by teaching and exercising close control; but interference with their management or the grant of pecuniary aid by Government impairs the fundamental principle of self-reliance.

Formation of small agricultural associations in Bengal.—What precise form private effort should take in Bengal, it is perhaps too early to prophesy. But undoubtedly there is every reason to believe, from the experience gained in other countries, that the formation of small agricultural associations should prove successful, whether as simple associations formed for the purpose mentioned in the preceding paragraph, or as co-operative societies dealing with the purchase of seeds and implements or with the distribution of agricultural produce. There is probably room for associations combining one or more of these functions. Apart from foreign experience and experience in other provinces in India, there is also the definite fact that such simple associations, serving thanas or even smaller areas, have met with marked success in the districts of Birbhum in the Bengal Presidency. By the co-operation of official organization and private effort of this nature not only will the successes obtained by experiment be brought to fruition in the interior, but Government will be furnished with a first-hand agency for ascertaining the real needs and the wishes of the agricultural population.

His Excellency in Council hopes, therefore, to see a further extension of this experiment throughout the province, particularly in those districts in which demonstration farms already exist or are about to be established, it is in those districts that the Agricultural Department can give the most help. The formation of such associations rests, however, with the public; and they will only be successful if they are financed and managed by the people. The principle accepted as essential by the Board of Agriculture in India, at their seventh meeting in 1911, was that those who are associated should be agriculturists, realy interested in local agricultural improvement,

The officers of the Departments of Agriculture and Co-operative Societies will be ready at all times with their advice and counsel.

Functions of existing associations.—The extension of such small associations, if carried into effect, will inevitably involve some alteration in the functions of the existing provincial, district and divisional agricultural associations. The district associations may, for exmaple, find, as time goes on, that their executive functions are being gradually absorbed by the working village societies. For the present, they may find that their duties are devoted to the organization of such societies. The development will of necessity be a gradual process, and the present associations will doubtless adapt themselves to changing circumstances or give way to a different organization if they cease to satisfy a real need.—Extracted from the Agricultural Journal of India, Vol. XIV, Part V.

III

Sugar and the Indian Empire.

India was at one time the largest producer of sugar of any country in the world, but so far as statistics show at the present time it occupies the second place in the list, Cuba coming first. However, it must not be forgotten that statistics in British India are by no means complete, whilst those of the native States are still less so, consequently much of the sugar which is produced and consumed by the natives is unrecorded.

The annual production of sugar in India in 1915 was 2,600,000 tons from cane. and about 500,000 tons from palm. This sugar was the soft variety made by the natives under the name of gur (Sanscrit gud) or jaggery for their own consumption. In 1917-18 the yield of cane gur had increased to 3,311,000 tons, but in the year following it had dropped to 2,337,000 tons owing to deficient rainfall, more especialy in Northern India.

The annual consumption of sugar in India in 1905 was 3,750,000 tons, including palm sugar, which left a deficit of 753,000 tons, which was made by the importation of white sugar from Java, Mauritius, and other countries. The imports, of white sugar into India in 1913, amounted to over 800,000 tons, some of which came from Germany and Austira-Hungary.

The consumption of sugar in India is on an average just below 17 lb. per capita per annum. Large quantities of cane, however, are

in addition chewed by the natives, and do not therefore appear in the statistics. The sugar consumed by the natives is exclusively the soft variety above referred to.

The area under sugar-cane and sugar-yielding palms for the season 1916-17 was estimated to be as follows :—

Sugar-cane	... ...	2,437,000 acres.
Palm	... ...	175,000 ,,

For the following year the acreage for cane is given as 2,837,000.

The cane was estimated to produce 2,626,000 tons of gur, and the palms 400,000 tons of gur, a yield of 1·08 tons and 2·028 tons per acre respectively. These figures have, however, little significance so far as our object is concerned, for the present small holdings will have to be converted into centralised estates if any real improvements are to be effected in India as regards increasing the yield of any quality of the sugar.

The exports of sugar from India for the three years prior to the war were as follows :—

	1911-12 cwt.	1912-13 cwt.	1914-15 cwt.
Sugar 16 Dutch standard and above ...	25,388	32,214	30,368
Sugar 15 Dutch standard and below ...	175,895	287,853	161,269
Confectionery	...	83	93
	201,283	320,150	191,930
	Tons. 10,064	Tons. 16,007½	Tons. 9,596½

The average yield of cane per acre differs in various parts of India. In the Northern Province, including United Provinces, Punjab, Bihar and Orissa, Bengal and Assam, which together constitute 91·6 per cent. of the total sugar-growing area of India, where for the most part thin canes are grown, the average yield of sugar in the current year was only 0·72 ton per acre. On the other hand, in the Southern Provinces, Madras, Bombay and Sind, situated in the tropics, where thick canes are grown, the average yield of sugar was 1·95 tons per acre.

In considering the sugar problem in India we have in the first place to bear in mind that the sugar is produced by the natives on

small holdings, by very primitive methods. The juice is expressed by bullock-driven mills, by which at most 50 per cent of the sugar is extracted, the remainder being left in the bagasse which is used as fuel. Then again, the juice is evaporated in open pans so that in this way much of the sugar is destroyed, amounting sometimes to another half (see Reports by Mr. William Hulme and P. Sanghai, 1918).

On the other hand, we have been informed by Mr. J. MacKenna, Agricultural Adviser to the Government of India, that in the Bombay Presidency in the area under canals, where cane is specialised, the yield of Pundia cane which is generally grown is as high as 40 tons per acre; this being due to heavy applications of manure and to irrigation. These yields are possible owing to the district, and no criterion can be drawn from them as regards the rest of India. With such a yield of cane, however, and assuming that the variety cultivated was the best suited to the district, it should be possible with modern methods of extraction and manufacture to obtain 4 tons and upwards of sugar per acre.

It should here be mentioned that in India wild boars, jackals, mice, white ants, and borers, beetles and grasshoppers do much damage to the cane crops, besides a host of parasitic fungi.

In some correspondence between Mr. Kelavakar and one of us (J. W. Macdonald) in 1916, Mr. Kelavakar draws attention to the facts given by Mr. MacKenna. He is strongly of opinion that if some firm of standing such as Messrs. Henry Tate & Sons in England, would start a factory in India, the money for the scheme would be subscribed at once, and the Government would find every facility.

It must not be forgotten, however, that the native desires a soft, luscious sugar of the character of the gur which is now produced by such primitive and wasteful methods. Bearing this in mind one of us (J. W. Macdonald) made the following recommendations in a letter replying to Mr. Kelavakar:—

"I would recommend an up-to-date factory to produce a good class *first quality* raw sugar for export to England, and a *second quality* for local consumption, making it as near as possible to the sugar now favoured. The second quality would be made from the syrup coming from the centrifugals which would spin the first quality, but owing to careful manufacture it would be really better than the crude sugar now produced direct from the cane juice. The syrup would be concentrated in the vacuum pans, but not boiled to grain. It would be boiled to string-proof only, *i.e.*, thick, with say 10-12% water, and then

run off into cooling tanks, and allowed to crystallise slowly. It would be finally spun in the centrifugals so as to produce a *soft low sugar* containing a large amount of molasses, and would be very sweet, and pleasant to eat. It would be a *clean, wholesome product.* The more molasses left in it, the cheaper it could be sold, and the less molasses there would be to sell as such. The production of India at present is 2,600,000 tons, but I am sure the same canes with careful manufacture would produce another million tons or more, as the waste must be very great.

"What we want over here is good, dry crystal sugar, loose grain (not solid) made from the juice, and packed in strong 2 cwt. bags. The colour should not be spoiled by mixing low products with first boiling. These low products should be sold separately, and there is a boundless market in India for them, particularly if care be taken in their manufacture to keep them clean and wholesome. If the first qualities be made to a standard colour and analysis, and be free crystallised sugars (not solid), and be packed in good 2 cwt. bags, I am sure they would command a leading position in the English market, particularly as they would be Empire Sugars."

The most feasible means of extending the sugar industry in India appears to be the establishment of central factories in which all interested in the manufacture co-operate and are bound by legal contract to assist one another. The factories must be fitted with up-to-date power mills, vacuum evaporating plant, and other modern machinery. This would naturally necessitate considerable organisation and research and the outlay of much capital. The Indian sugar industry greatly needs capital to extend it. Mr. Wynne Sayer is of opinion that the capital necessary for the development should be forthcoming in view of the assistance available from Government sugar experts, which has made it possible to overcome many obstacles which formerly obstructed progress.

We may point out that for several years past experiments have been carried out by Dr. C. A. Barber on the growth of seedling canes, and many thousands of new plants have been raised in this way.

In Southern India gur is made from various species of palm, and as already mentioned the sugar so made amounts to something like half a million tons per annum, the principal sources being the wild date *(Phœnix sylvestris)*, fan palm *(Borassus flabelliforus)* and the cocoanut palm *(Cocos nucifera)*.

Mr. H. E. Annett has studied the production of sugar from palm, and has published several papers on the subject. It appears that 2·3

tons of gur can be obtained per acre of palms, so that this source of sugar supply is one of importance.

Sugar beets have been grown experimentally in the Punjab, the North-West Provinces and Kashmir, but we have up to the present received no information regarding these crops.

As will have been seen from the above there are in India several scientific men of high standing who are continually prosecuting valuable research work in connectien with the sugar industry. We are of opinion, however, that considering the magnitude of the problem of the possible extension of the sugar industry in India, there would appear to be a lack of co-ordination among these workers, and we believe that the immediate future calls for the establishment of a large number of experimental stations, together with more scientific workers. Only by such means can a secure foundation for the establishment of a sugar industry in this vast Empire be secured. The problems awaiting solution consist not only in the selection of suitable canes for various districts, but also in combating numerous pests and for this purpose the services of zoologists and cryptogamic botanists are needed.

That the sugar problem is worthy of serious attention follows from the fact as we have seen above, that there are vast additional areas awaiting cultivation, whilst there is also a plentiful supply of the necessary labour.—Extracted in the Tropical Agriculturist, October 1919, from report prepared by the Society of Chemical Industry.

IV

Must we change our opinions on Crop Rotation?

By Arthur H. Rosenfeld.

The sage old philosopher who remarked that "there is nothing new under the sun" was undoubtedly observing a pretty general truth, but it cannot be denied that, in agriculture as in most other science, our old and well-established conceptions of this or that law or theory are being constantly replaced and supplemented by new points of view. The author recalls, as a college boy, when he considered that he had just mastered the Atomic Theory after considerabe application on his part and patience on that of his Professor, that he considered it almost a personal affront when, within a year or so, the Ionic Theory came to succeed, or, rather, to supplement what he had so recently mastered as the "last word" on

the ultimate division of matter! He had this thought in mind a few months ago when a friend of his an astronomer who has been making some really remarkably interesting parallel investigations—told him that he was just about to revolutionize the general opinion of the distance of the stars from the earth. "Well," I told him, "posterity may thank you, but those youngsters in the Universities who are just concluding the memorizing of what are now considered as the established distances will not thank you a bit."

In an article in this Journal a couple of years ago the author said "The value of crop rotation is so well recognized and accepted in agricultural practice and science that an experiment to demonstrate its value at times seems almost a redundancy. Nevertheless it is very often the most accepted principles—*axiomatic* one might almost call them—in agriculture whose demonstrations are most frequently neglected." And along with the almost axiomatic acceptation of the agriculturists, the absolute assurance that he who grows legumes in his rotation, is but *storing up nitrogen*, obtained from the air, for the use of future generations of money-making crops. And the man who is the sur est of all that he is leaving a precious heritage of nitrogen for his children and grandchildren is he who is cultivating these legumes year after year on the same land. For have we not learnt that a good crop of clover, cowpeas, or alfalfa absorbs from the air, where there is an inexhaustible abundance of this element, from one hundred to two hundred and fifty pounds of nitrogen per acre, which, naturally we have always assumed is stored there for the production of future mammoth crops of potatoes or corn or sugar-cane? Yet, when we come to investigate carefully our nitrogen bank account, we may find that, instead of having a comfortable balance to our credit, we have overdrawn our account most considerably. And if any of our readers have doubts on this score, we should seriously advise them to read a most illuminating and scholarly article entitled "Does Crop Rotation maintain the Fertility of the Soil?" by Dr. J. E. Greaves, Chemist and Bacteriologist of the Utah Experiment Station, published in No. 5 of Volume 6 of "The Scientific Monthly." It is of this article that the author intends in this paper to make short review, without claiming the slightest originality for the observations made therein, these observations being due entirely to Dr. Greaves.

"The farmers of ancient Rome," says Dr. Greaves, "understood that crops following beans, peas, and vetches were usually better than those following wheat or barley; but it was not until the last quarter of the nineteenth century that it was learned that the legumes with

the aid of associated bacteria have the power of feeding on the free nitrogen of the air, while the non-leguminous plant has not this power and requires a supply of combined nitrogen. To-day we find the best farmers practising some system of crop rotation. They have learned from experience that where crop rotation is practised the crops are bigger and better than where the single crop system is followed. This is usually interpreted as indicating that crop rotation has increased the fertility of the soil." Let us see, with Dr. Greaves, if the best experimental evidence will bear out this most generalized belief.

The intelligent agriculturist of to-day knows that all plants are composed of the elements which are individually and collectively essential to their development. Of these, carbon and oxygen are at the disposition of all plants in the air, whereas water furnishes the hydrogen. The other seven elements nitrogen, phosphorus, potassium, magnesium, calcium, iron, and sulphur—must be obtained by the growing plant entirely from the soil, with the exception of one family of plants—the legumes—which under appropriate condition may obtain their nitrogen from the air, by means of the little nitrogen-fixing organism *Bacillus radicicola*.

The intelligent farmer also knows that, of these ten elements, only three—nitrogen, phosphoric acid and potash—are likely to be deficient in his soils, but that these are precisely the ones which are most used by growing plants, and that, according to Liebig's well-established "Law of the Minimum," the deficiency of his soil in one or more of these three elements limits immediately his crop production. He is likewise conversant with the fact that no system of crop rotation will enable him to maintain the phosphorus and potash in his soil in face of constant crops therefrom, as each crop is bound to remove a certain quantity of these elements, the only means of replacing it at present known being by means of recourse to commercial fertilizers. Nitrogen, however, can be replaced by rotation, and it happens that this is the element which is generally found in the soil in smallest quantities, which is most easily leached therefrom, and which is most needed by growing plants. We may, therefore, safely assert that the limiting factor in most soils for the production of profitable crops is its nitrogen content. In the words of Dr. Greaves, "this principle is one of the fundamentals of soil fertility."

The chemists tell us and have proved it by innumerable experiments that the quantity of nitrogen in the air is absolutely inexhaustible, lying over the earth's surface in the proportion of some 7 tons per square yard of land, the value of the nitrogen covering

every acre of land on the earth, were it combined in the form of nitrate, being about twenty-five million pounds sterling. We know that the legumes, when properly infected with the *Bacillus radicicola*, have the power of feeding on this air-nitrogen, and that the non-legumes have not this power, hence it is simply a commerical proposition that the farmer should obtain as much of this nitrogen from the air as possible. "But," asks Dr. Greaves, "will the legume draw nitrogen from the atmosphere while there is a supply in the soil, or will it follow the line of least resistance and turn only to the atmosphere when nitrogen is lacking in the soil? If it does, it must first drain the soil of its nitrogen, and thus leave it no richer than it was before the legume was grown upon the soil." Here, then, is the problem in a nutshell.

The evidence given by the oldest of all serious rotation experiments—those at the Rothamsted Experiment Station—which were inaugurated in 1848 and are still being run in the same way as when started—seem to confirm the theory of the legumes exhausting the most easily obtained nitrogen—that from the soil—before having recourse to that of the air. In a rotation of rutabagas (swedes) the first year, barley the second, clover or beans the third, and wheat the fourth, parallel to one with the same crops with the exception of the legumes, in which year the land is left fallow, the results were divided into three twenty-year periods, a decided decline being found in the yields for each successive period, both where legumes were used and where they were not. From the first to the third periods, in the legume rotation the rutabaga yield fell off to one-sixth of the original while the barley yield fell to about one-third, the clover yield itself in the same period falling off from about 2 tons per acre to just about 1½ tons. The fallow rotation shows no greater decline than the clover one, and "both systems strongly testify to the fact that rotation is not maintaining the productive powers of this soil. And the evidence is strong that the legume gets no more nitrogen from the air than that which is removed with the plant. Otherwise we should expect better results in the legume system than in the fallow system." A most disturbing conclusion is for those who have been sure for years that they are gradually accumulating a stock of nitrogen in their soils.

Experiments made in the Illinois and Utah Experiment Stations have shown conclusively that the legume, where the crop is harvested, does not increase the soil nitrogen, the legumes, even in the poorest soils, first feeding on the soil nitrogen, and then having recourse to the air for what they still lack for the completion of their

growth. In the Utah experiments it was conclusively shown that the legumes, alfalfa being the one under trial, remove the nitric nitrogen which is formed from the ammonia in plant residues and other complex nitrogen compounds found in the soil by bacteria distinct from those which convert the nitrogen in these compounds into the ammoniacal forms from the soil just as fast as the non-legumes do. And Dr. Greaves further observes that alfalfa soil "never contains more (nitrogen) than does oats and corn land, and is very poor as compared with potato and fallow soil."

True it is, as has been shown in the Utah Experiment Station's work that the quantity of soluble nitrogen produced in an alfalfa soil is greater than that produced in oat or corn soils, and, as Dr. Greaves remarks, "there is no doubt that this is one reason why an increased yield is obtained the year following the ploughing-up of an alfalfa field (see the author's article in this Journal, already referred to); for this increased nitrification is noticed for several years after an alfalfa field is planted to some other crop. This is due to the alfalfa plant stimulating bacterial organisms in the soil of its nitrogen faster than does the non-legume, for it is the nitrogen already combined in the soil on which the nitrifying organisms act. Hence, we must conclude that alfalfa not only feeds closer on the soluble nitrates of the soil, but it also makes a greater drain upon the insoluble nitrogen of the soil by increasing the nitrifying powers of the soil, and would therefore deplete the soil, if the entire crop be removed, more readily than would other crops, a conclusion which is borne out by the direct analysis of the soil. For the analysis of a great number of Utah soils which have grown various crops for a number of years—some of them having been put into alfalfa or wheat for upwards of thiry years—revealed the fact that almost invariably the alfalfa soil contained less total nitrogen than did the wheat soil."

These results certainly indicate that in ordinary farm practice the alfalfa is making just as great a drain upon the soil nitrogen as is the wheat, as Dr. Greaves rightly observes. Let not our readers, however, think that these results show that rotation should be abandoned as a logical farm process. By no means! These results undoubtedly show that the legumes do not increase the nitrogen of the usual agricultural soil when the entire crop is removed—this they show most convincingly but the lesson to be learned from them is not that *we must abandon* rotations, but that *we must make our rotations more thorough!* If the legumes do not get their nitrogen from the air until they have exhausted that more easily available

from the soil, let us secure for our soils the excess which they have got from the air by turning under and not cutting them for sale, at least not in their entirety, or by pasturing them with live-stock, thus assuring the return, of a large part of the nitrogen in the droppings of the animal! By doing so it is easily possible to increase our store of soil nitrogen and secure increased yields from other crops in any scheme of rotation—without "robbing Peter to pay Paul" through stimulating bacterial activity in our soils and thus using up our reserve soil nitrogen more rapidly. "An ounce of prevention is worth a whole barrel of cure."—*The International Sugar Journal, November 1918.*

Agricultural Middle Schools in Madras.

Extracts from the report of the Committee appointed to draw up proposals for the opening of two such Schools.

1. In the first place the committee feel that they are face to face with a problem of the very first importance, since it is obvious that on the success or otherwise of these schools depends what can hardly be less than a revolution in general rural education. Rural education itself forms the second of the terms of reference of this committee, but if rural education is to be successful, it is these agricultural middle schools that we must use as a training ground for teachers. The committee therefore desire to emphasise most strongly that these schools should be opened only under conditions which will give them the greatest possible chance of success.

2. The first of these conditions is, in the opinion of the committee, the appointment of none but absolutely suitable masters to such schools. It is one of the greatest obstacles to the demonstration work of the Agricultural Department that, unless the demonstrator belongs to the same class as the farmers whom he is addressing, and is besides of some standing in the locality, he is regarded with indifference amounting at times almost to contempt, and his efforts fail in consequence. The committee are strongly of opinion that these schools will not of themselves attract any appreciable number of suitable pupils, in view of the novelty of the idea, and the general indifference to the value of non-literary education—an education which does not lead directly to Government service or the learned professions. The experience of Bombay as set forth by Mr. Keatinge, Director of Agriculture, in his letter printed on pages 8 and 9 of G. O. No. 2552, Revenue, dated 6th July 1918, confirms us in this view. The committee, therefore, desire to reiterate their firm conviction that the success of such schools depends mainly on the selection and procuring of

the right type of masters.

5. The subjects to be taught at these schools fall roughly into three groups :—

(*a*) Technical class work.
(*b*) Non-technical class work.
(*c*) Practical out-of-doors work.

For teaching the first and last of these an agricultural diplomate is necessary, and to maintain the balance between the various subjects which the committee have decided to recommend—vide paragraph 17 below—a total teaching staff of three for each school will be required, two of them L. Ag.'s and the third a trained non-technical teacher.

The committee consider that it is absolutely essential to the success of any school that the two agricultural masters *should belong to the same class as the farmers of the locality and should besides be of some standing in that community*. Unless this is the case, parents will have no confidence in the school and it will not be possible to secure the right type of pupil. While it is desirable that the third non-technical master should also fulfil this condition, it is not absolutely essential that he should do so.

The school course should extend over two years, and in view of the essentially practical nature of the work, the strength of a class should be limited to 20 pupils. It therefore follows that there will be 40 pupils in residence at any time.

13. *Fees.*—The question of the fees to be charged received the careful attention of the committee. On the one hand it may be argued that it is impossible to test the demand for education of this nature unless full fees are charged from the beginning. On the other hand it must be admitted that it will in any case be difficult to secure pupils at first, and that if heavy fees are charged the experiment will fail from the start. The committee have endeavoured to fix the fees at a figure which will enable the school to compete on favourable terms with existing middle schools. The committee therefore propose an inclusive fee of Rs. 15 per term, although it is recognized that the actual cost of maintenance will probably be nearer Rs. 25 per head per term. [The G.O. states that the desirability of making these schools as nearly self supporting as possible should be steadily kept in view; the Director is asked to report later on the question of enhancing the fees.—Ed.]

14. The school terms should be from 1st May to 15th August, 15th September to 15th December and 15th January to 31st March.

[*N.B.*—These terms are selected for this school to suit local seasons. They would not necessarily apply to other tracts.]

The general idea is that the boys should be at the school at the important seasons of planting and harvesting, but should have a holiday at home while the crops are growing. The general hours of working are—a spell of practical work, farm work, surveying, etc.—in the morning for about three hours. After this, a midday interval of four hours, during which the boys bathe, clean up their rooms and have their midday meal. Class instruction starts at 1 p. m. and is given in four periods of 45 minutes each. In the evening about a third of the pupils will, in roation, attend to the current farm routine, watering and feeding the animals, etc. ; the rest will play games, go out for walks, and so on. Evening meal 6—30 and preparation from 7 to 8—30. Saturday a half holiday, though routine work must be attended to both on Saturday afternoon and Sunday. * When two classes are in residence, i. e., as soon as the school gets into full working order, the field and class room work of the two sections will alternate.

15. The school will have its own land and buildings. Some of the lands of the present agricultural station at Taliparamba will be handed over. In addition to this 4 acres of wet and 40 acres of dry land must be acquired. The buildings should be at first of a temporary character. In general these buildings should approximate to the local style of rural architecture, with the possible exception of an increase in the window space. They will be arranged in a square, the houses of the three members of the teaching staff being detached buildings along one side. Opposite to each will be two long L shaped blocks containing on one side the living rooms in the long arm and the kitchen in the short one, and on the other the teaching rooms and the museum. Besides this, outhouses, bath rooms, latrines, farm buildings and a workshop will be necessary. The following details indicate the scale considered desirable :—

	SQUARE FEET.
Three quarters each 2,000 sq. ft. area ...	6,000
Two class rooms each 400 sq. ft.	800
Museum	400
Masters' room and office	200
Preparation room, 200 ; * store room, 150 ...	350
Eight rooms for five boys each 400	3,200
Kitchen, 200 ; dining room 800	1,000
Kitchen store room, 150 ; latrines, 50 ; and bath room, 100	300
Matron's room	200
Farm buildings, 2,000 sq. ft.	2,000
Total ...	14,450

* These two may be combined.

16. The boys will help with the preparation of their own food and it will be part of their duties to keep themselves and their rooms clean. Furniture will probably not be needed, the boys sitting on mats as in their own homes; a system of monitors is considered desirable.

17. The staff will consist of three teachers. The headmaster will be a L. Ag. It is suggested that he be given his grade pay plus an allowance of Rs. 30 a month. He will be assisted by two teachers: one L. Ag. on his grade pay plus an allowance of Rs. 10; the third will be a trained teacher of the secondary grade, drawing a salary of Rs. 50. He should be preferably of the same or similar class as the agricultural teachers and should be a man of rather exceptional all round qualifications. Two agricultural men will be necessary to take all the out-of-door practical work of both classes and they will each take one period a day of the class teaching in Nature Study and Agriculture. The third treacher will take three class periods of 45 minutes each in the morning and three in the afternoon, except on Saturdays. A matron on Rs. 15 will also be required. Besides these, one permanent head coolie will be needed and the temporary services of a blacksmith or carpenter for the workshop classes.

[The G.O. does not sanction the proposed allowance to the Agricultural teachers; it also doubts the necessity for the service of a matron. Ed.]

18. The syllabus to be taught is that passed by the Poona Committee and printed in G. O. No. 2552, Revenue, dated 6th July 1918, with the following modifications:—

(1) The teaching of English as a separate subject is recommended, though vernacular is to be the medium of instruction throughout.

(2) Practical survey and map reading should be included.

(3) Several minor additions to "Nature Study" as given in the syllabus are suggested, e. g., weather, birds, and rural animal life.

Periods per week —

5, class room work in Nature Study and Agriculture.
5, Arithmetic, mensuration, surveying, map reading.
3, English.
4, Geography.
5, Vernacular.

Text-books for the pupils are neither necessary nor desirable. But the committee are certain that unless the teacher is furnished

with text-books containing all the matter which he is required to teach it is idle to expect satisfactory teaching.

The committee are decidedly of opinion that existing text-books on *Agriculture and Nature Study* are entirely unsuitable and that it is therefore necessary to compile a special book for the purpose.

20. *Cost.*—The initial and recurring cost of the school is estimated roughly as follows :—

Initial—Land—

	Rs.
Four acres wet at Rs. 300 each ...	1,200
Forty acres dry at Rs. 50 each ...	2,000
Total ...	3,200

Building—

Fifteen thousand square feet at 12 annas per square foot	11,300
Equipment	2,000
Total ...	16,500

Recurring—

One teacher on grade pay (average) plus, Rs. 30 local allowance (Rs. 122 per mensem) ...	1,464
One teacher on grade pay (average) plus Rs. 10 local allowance (Rs. 102 per mensem) ...	1,224
One teacher on Rs. 50 per mensem ...	600
One matron on Rs. 15 per mensem ...	180
One head coolie on Rs. 15 per mensem ...	180
Casual labour	500
Contigencies of all kinds	1,000
Repairs and upkeep	500
Feeding charge at hostel for nine months, 40 pupils at Rs. 8 per mensem ...	2,880
Total ...	8,528

Receipts—

Fees	1,800
Farm receipts	3,000
Total ...	4,800
Net recurring expenditure	3,728

Utilization of Banana Stalks.

An article on another page of this issue, on the value of megass for paper making, notes that by the combination of megass with banana pulp white paper of fine quality can be turned out. In *Sugar*, March 1919, it is stated that a new industry that will be of benefit to the sugar planters in Hawaii, is a sack factory shortly to be started. The sacks are to be made of banana fibre shipped from the coasts of the Caribbean sea through the Panama Canal. The estimated output of the factory will be 10,000,000 sacks per annum.

It is also stated that there has just been finally perfected in Honolulu a machine which will separate the fibre from the pulp of banana stems. As is well known, after the fruit is cut, the stem of the banana plant either dies of itself, or is cut away. For lack of machine capable of dealing with these stems the valuable fibre contained in them has hitherto been wasted. The ordinary banana acreage is given as from 400 to 600 plants. From each of these it is expected that 2lb. of fibre can be extracted by the newly invented machine. Besides extraction of the fibre the same machine separates the pulp which will make, as was mentioned above, an admirable ingredient in paper stock.

Considering that a banana plant consists of about 93 per cent water, 3 per cent fibre and 4 per cent pulp, and that the fruit from 85,000,000 banana plants was consumed in the United States alone last year, it will be seen that there appear to be great possibilities before this new industry, both in the production of fibre and in the utilization of the pulp in paper manufacture.

—*Agricultural News*, Vol. XVIII, p. 201.

School of Tropical Agriculture, Peradeniya, Ceylon.

On the results of the first School Course in English, January to December, 1916, recommendations were made to extend the period of the Full Course to two years, each year commencing in May, and ending in March so as to synchronise more nearly with the agricultural seasons. These recommendations were adopted for the class admitted in May, 1917, when thirty candidates were selected for admission, out of eighty-two applications received.

As in the majority of the secondary schools and colleges in Ceylon, the year ends with the Christmas vacation in December; each full course in Agriculture is advertised in the "Government Gazette" and the daily papers in December and applications are received and recorded for consideration up to February 1st. This is intended to afford to all students who complete their secondary education in any December and decide to take to planting, the opportunity for obtaining particulars and sending in their applications in time. No students can be admitted during a course. Only a limited number can be admitted to each course.

The students admitted in May, 1917, completed their course in March, 1919. The course consisted of four sessions covering 87 weeks of work. As a rule, the mornings were given to field work commencing at 7 A. M., and the afternoons to classroom work commencing at 1 P. M. The fieldwork consisted of the cultivation by each student himself of a plot of land with four sets (one each session) of economic crops in rotation; and of demonstrations and practical work connected with the various operations of planting and horticulture. The work and planting demonstrations were conducted at the Experiment Station, Peradeniya; the work in horticulture in the Royal Botanic Gardens.

The crops cultivated by the students during the course were; sorghums, maize, hill paddy, kurakkan; brinjal, bandakka, onions, chillies; cow pea, dhal, lima bean, green gram, groundnut; coriander, cummin, aniseed, fenugreek. The operations connected with cultivation, such as ploughing, horrowing, draining, manuring, etc., were studied, "Plot Diaries" were kept, and diseases and pests appearing on crops studied and methods of control employed.

The planting, cultivation and preparation of the following products were studied: cocoanuts, tea, rubber, cocoa, coffee, paddy, grains, plantains, papaw, vanilla, fibres, sugarcane, orchard and vegetable crops, and green manures; with the pests and diseases associated with them and method of control.

In horticulture, the subjects of instruction may be summarised as follows: propagation, grafting, inarching, budding, pruning, storing, packing, transporting, pollination, felling, lawn-making and the study of useful and ornamental plants.

The classroom instruction was grouped under five heads, the instruction in each sub-division having been intended to give a general survey of the elementary principles of each. These divisions were;

Agriculture, mainly fieldwork, also Agricultural Engineering comprising, chain surveying, roads and drains, machinery and buildings and Elementary Meteorology; *Agricultural Botany* covering General and Economic Botany and the Diseases of plants: *Agricultural Zoology* covering cattle, their breeding, feeding and diseases, dairy practice, and plant pests; *Agricultural Chemistry* including elementary plant, soil and animal chemistry, the study of soils, manures and manuring; and *Agricultural Economics* comprising Co-operation and Estate Accounts.

In Co-operation, the work of Co-operative Credit Societies as established in the Island was studied, the lecturer being the Secretary of the Board of Control. Several Passed Students have associated themselves with the work of such societies and accomplished good work.

In Estate Accounts, the work done has been of a high standard and was conducted by Mr. D. Clement De Silva, Chief Clerk of New Peradeniya Estate, who considers that students holding the full certificate of the school are competent to take charge of the books of an estate. We have been fortunate in securing as lecturer in Accounts one who is not only actually engaged in keeping Estate Books, but has also proved successful as a teacher.

The acting Manager, Experiment Station, Peradeniya, conducted the instruction in Planting; and the Curator, Royal Botanic Gardens, in Horticulture. The rest of the instruction was conducted by the School staff.

In practical Chemistry, classes were conducted by arrangement in the laboratories of Trinity College, Kandy. The work was however greatly impeded by the difficulty in obtaining sufficient apparatus and chemicals owing to the war.

In January, 1919, a trip was arranged to Anuradhapura for the study of dry zone cultivation under irrigation. The students were given two whole days, one day at the Anuradhapura Experiment Station and one day for the surrounding district. The essays submitted after the trip showed that students had on the whole formed sound conclusions.

The class consisted of 30 students drawn from the following Provinces: Southern Province 12, Western 9, Central 3, Northern 3, North-Western 1, Sabaragamuwa 1, Uva 1. There were 22 Singhalese students, 4 Tamils, 3 Burghers and 1 Malay. Of them, one withdrew at the close of the first session; one died during the first vacation; one was called on to resign in December, 1917; and one

was permitted at the close of the first year to come up for his second year in May, 1919, owing to financial difficulties. Twenty-six students completed the course satisfactorily, with an attendance of over 90 per-cent on the whole course, except in 3 cases: two owing to prolonged illness at home, and one owing to absence on military duty.

All students resided in the school hostels under adequate supervision. The tone of the hostels was high and the health good.

The Students' Council, elected by the student body from among themselves, did good work in safeguarding the interests of the school against factions or class prejudices, in organising student activities, and in assisting in the maintenance of good order and discipline at work, in hostels and on outings.

The third number of "The Peradeniyan" was almost entirely the work of this class. In the Students' Debating Society, much good work was done during the first year; in the second year, the Society suffered from the pressure of the regular studies. In sports, the class made a big advance in the Tennis Club, raising it to a high pitch of efficiency; "volley ball" was also added to the school games; the football team was good, but little football was played owing to want of practice. As a rule the students had too much field work to allow them to give a great deal of energy to sports.

Examinations were held at the close of each session: sessional examinations in September 1917 and September 1918; an examination on the first year in March, 1918; and an examination on the whole course in March, 1919. During the course, notes of all lectures and classes were checked weekly by lecturers and demonstrators the marks so awarded being considered side by side with examination results.

The results of the course were satisfactory. Of the 26 students who completed the course, 22 have been awarded full certificates, 2 certificates excluding Estate Accounts, and one a partial certificate.

From the Tropical Agriculturist, Vol. 11, No. 6.

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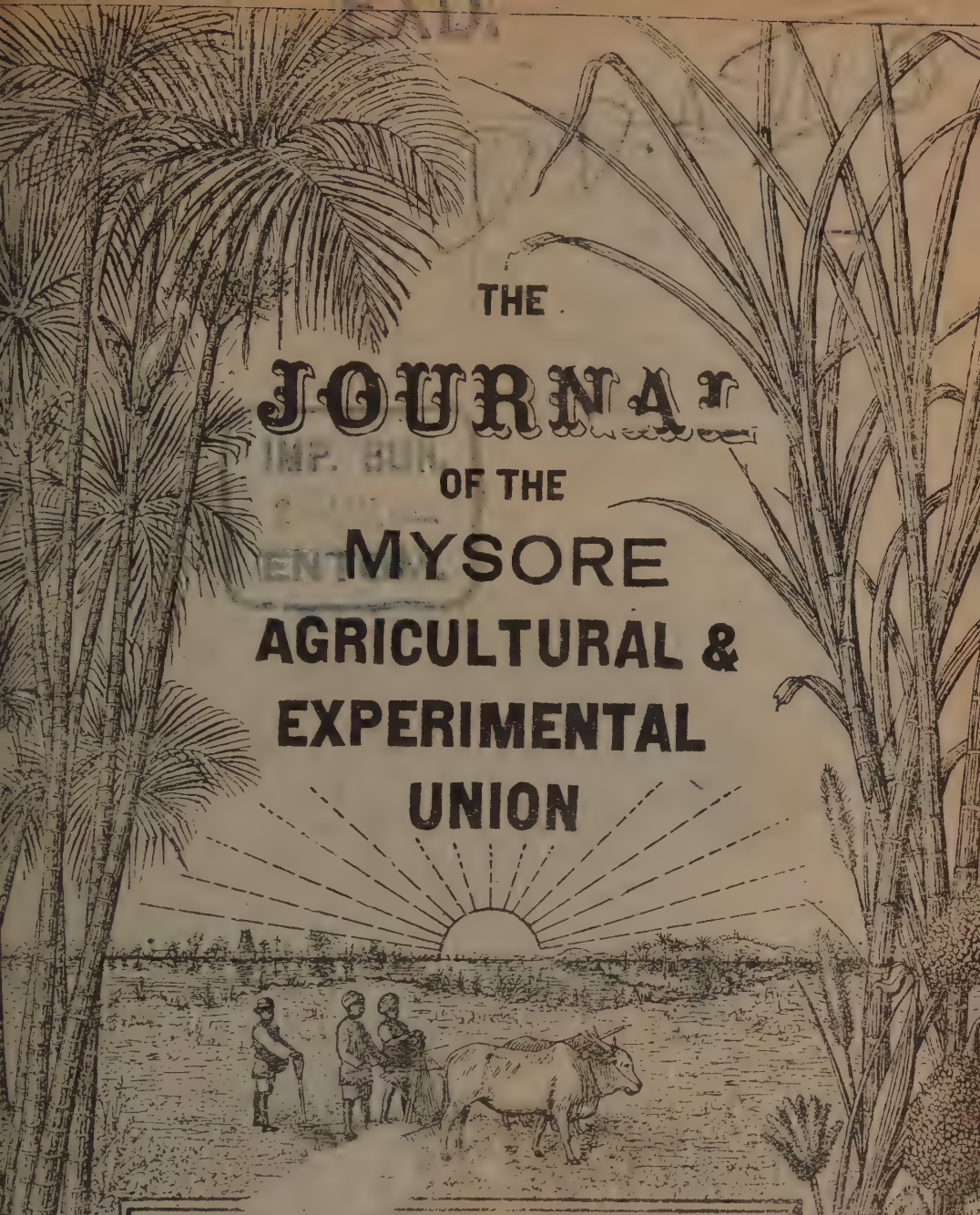

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By Dr. Gilbert Slater, M.A., D.Sc.

Mango Hoppers
By K. Kunhi Kannan, M.A., F.E.S.

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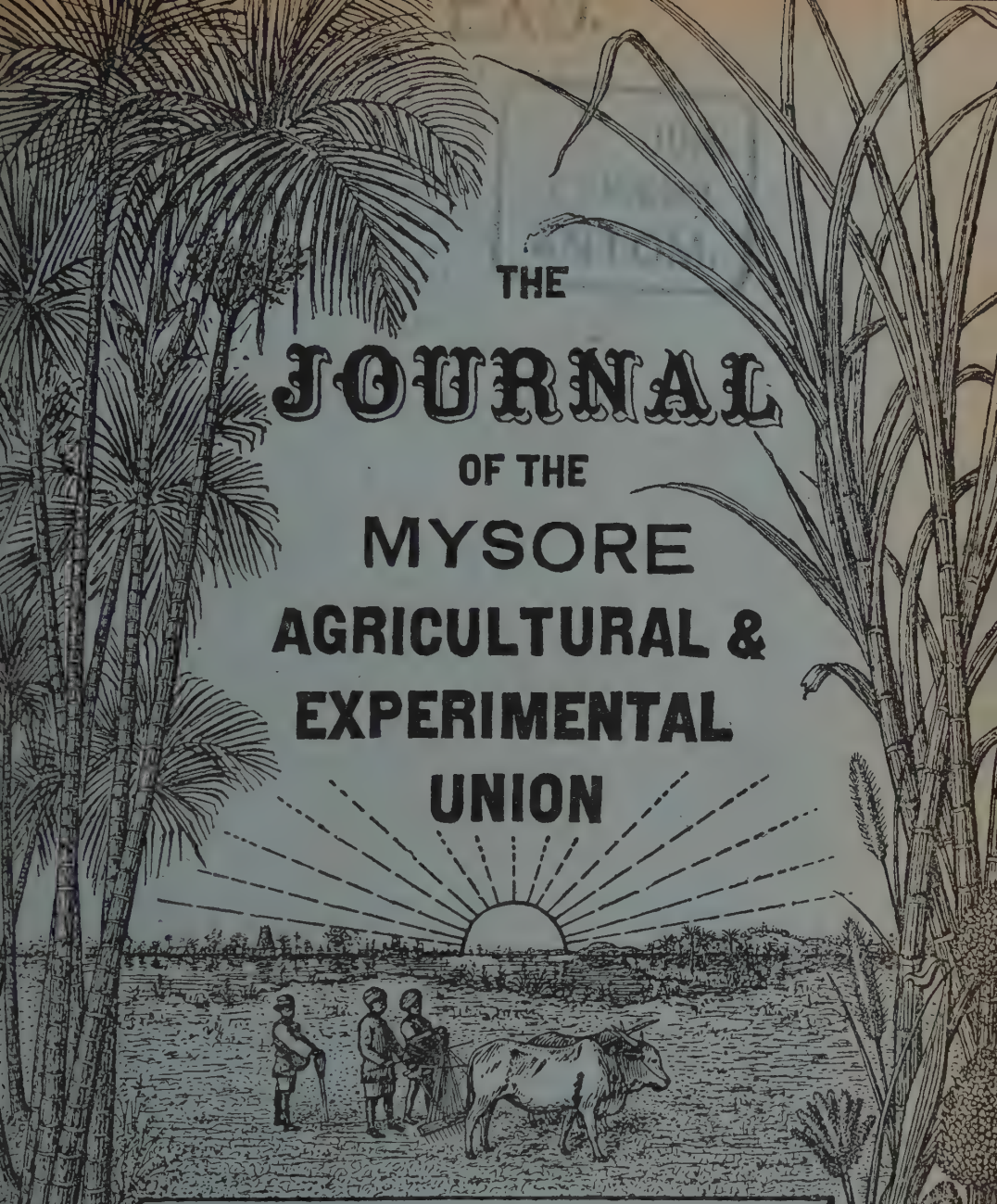

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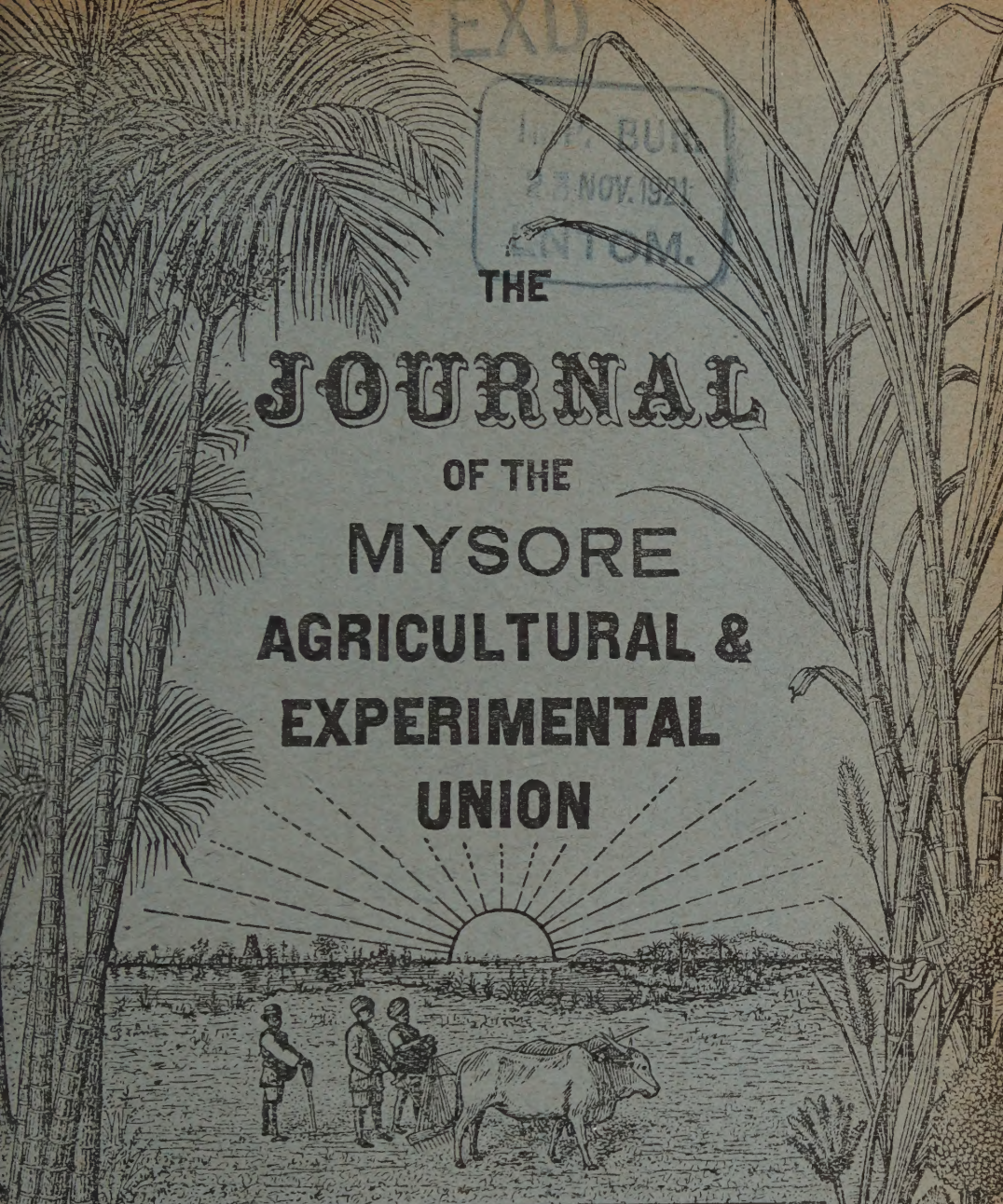

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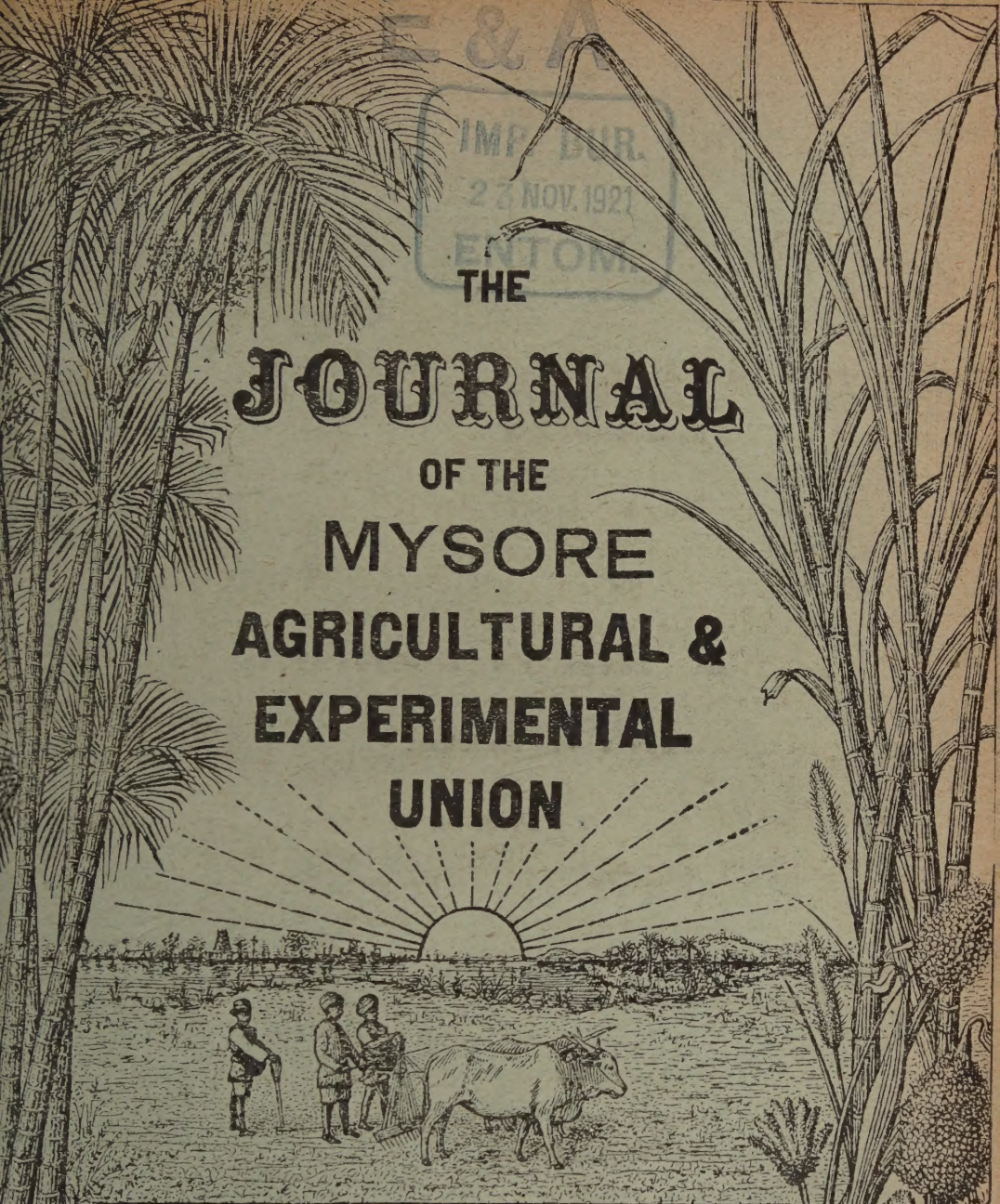

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